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Dissociable Effects of Conscious Emotion Regulation Strategies on Explicit and Implicit Memory

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The authors manipulated emotion regulation strategies at encoding and administered explicit and implicit memory tests. In Experiment 1, participants used reappraisal to enhance and decrease the personal relevance of unpleasant and neutral pictures. In Experiment 2, decrease cues were replaced with suppress cues that directed participants to inhibit emotion-expressive behavior. Across experiments, using reappraisal to enhance the personal relevance of pictures improved free recall. By contrast, attempting to suppress emotional displays tended to impair recall, especially compared to the enhance condition. Using reappraisal to decrease the personal relevance of pictures had different effects depending on picture type. Paired with unpleasant pictures, the decrease cue tended to improve recall. Paired with neutral stimuli, the decrease cue tended to impair recall. Emotion regulation did not affect perceptual priming. Results highlight dissociable effects of emotion regulation on explicit and implicit memory, as well as dissociations between regulation strategies with respect to explicit memory.

Keywords: affect, cognitive control, emotion, emotion regulation, memory

On a daily basis, lives are shaped by emotions, including joy at successes, sadness due to losses, and fear in the face of threats. However, emotions are often not experienced passively. Instead, individuals engage in emotion regulation (Gross, Richards, & John, 2006), attempting to modulate the behavioral, experiential, or physiological components of emotions (Gross, 1998b). Successful emotion regulation is associated with positive outcomes, including development of social competence (Eisenberg, Fabes, Guthrie, & Reiser, 2000) and improved subjective well-being (Larsen & Prizmic, 2004), whereas emotion dysregulation figures prominently in psychopathology (Gross & Munoz, 1995) and may be a precursor to problematic behaviors, including violence (Davidson, Putnam, & Larson, 2000).

Various emotion regulation strategies have different behavioral effects, as demonstrated by investigations of reappraisal and expressive suppression. Reappraisal refers to cognitive attempts to change the meaning of stimuli, while expressive suppression refers to inhibition of emotionally expressive behavior (Gross, 1998b). Several studies have examined the effects of these strategies on stimulus encoding. Reappraising gruesome films as less distressing reduces self-reported negative emotion and physiological arousal (Lazarus & Alfert, 1964). Furthermore, using reappraisal to enhance and decrease responses to unpleasant pictures leads to increased and reduced startle responses, respectively (Jackson, Malmstadt, Larson, & Davidson, 2000), as well as increased and reduced activity in the amygdala (Ochsner et al., 2004). Less is known about the neural correlates of expressive suppression, but this strategy leads to increased sympathetic nervous system activity and does not effectively modulate unpleasant emotional experience (Gross, 1998a; Gross & Levenson, 1993, 1997).

Thus, reappraisal and expressive suppression differentially affect stimulus encoding. But what about consequences for cognitive functions such as memory? Emotional influences on memory have been well-studied. Although naturalistic research indicates that very high levels of emotional arousal can impair recall (Deffenbacher, Bornstein, Penrod, & McGorty, 2004; Kramer, Buckhout, & Eugenio, 1990), recent behavioral and neuroimaging studies have consistently revealed retention advantages for emotionally arousing material (Cahill & McGaugh, 1995; Dolcos, LaBar, & Cabeza, 2004; Hamann, Ely, Grafton, & Kilts, 1999; Heuer & Reisberg, 1990). In general, however, relatively simple encoding tasks (e.g., valence judgments) have been used in laboratory studies of emotional memory, leaving a critical question unaddressed: Is memory susceptible to modulation by emotion regulation strategies?

A small number of studies have examined this issue. The most consistent finding is that expressive suppression, engaged at encoding, impairs explicit memory. In two initial experiments, Richards and Gross (1999) presented participants with low- and high-arousing unpleasant slides depicting wounded men and paired with biographical information. At encoding, one group of participants passively viewed the slides, while a second group engaged in expressive suppression. Across both experiments, expressive suppression led to worse explicit memory for the biographical information. Intriguingly, this result did not vary according to the emotional nature of the slides—the negative impact of expressive suppression on memory was equivalent across the low- and high-arousing slide sets.

Richards and Gross (1999) suggested that these results reflect the fact that in order to inhibit ongoing emotion-expressive behavior, individuals must divert attention away from stimulus encoding

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in order to monitor their physiology and facial expression. To test this hypothesis, they compared expressive suppression with reappraisal (Richards & Gross, 2000). Expressive suppression involves altering an ongoing emotional response and has been classified as a response-focused regulation strategy (Gross, 1998a, 1998b). By contrast, reappraisal may be used to influence an emotional response at the outset and thus has been classified as an antecedent-focused regulation strategy. Richards and Gross (2000) proposed that reappraisal consists of a decision to reinterpret an emotional episode at its inception. Once this decision is made, the emotional nature of the episode is changed, little additional cognitive work is necessary, and encoding may proceed as usual. Accordingly, Richards and Gross (2000) predicted that expressive suppression would impair explicit memory but reappraisal would leave it unaffected. At encoding, participants were again presented with low- and high-arousing unpleasant slides paired with biographical information. One group passively viewed the slides, another engaged in expressive suppression, and a third group engaged in reappraisal, viewing the slides from the detached perspective of a medical professional. Results were partially consistent with predictions. Compared with passive viewing, expressive suppression again led to worse explicit memory for biographical information paired with both low- and high-arousing slides. Unexpectedly, however, reappraisal led to better explicit memory for the high-arousing slides than either passive viewing or expressive suppression.

In a third study examining the effects of emotion regulation on memory, participants manipulated their facial expressions while viewing pleasant and unpleasant slides (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004). On some blocks of trials participants enhanced facial expressions of emotion; on other blocks they engaged in expressive suppression, and on additional blocks they received no special instructions. Encoding was followed by a multiple-choice test for details of the slides. Compared to the uninstructed condition, both enhancing and suppressing emotion-expressive behavior resulted in impaired memory performance.

Collectively, these three studies demonstrate that emotion regulation strategies can affect explicit memory, but the psychological mechanisms underlying these effects are unclear. Results from all three studies are consistent with the hypothesis that expressive suppression is cognitively costly and impairs explicit memory (Richards & Gross, 2000). However, the prediction that reappraisal requires few psychological resources and should have little effect on memory is not well-supported. First, studies of stimulus encoding reveal that reappraisal recruits activity in neural regions associated with executive control and can affect psychophysiological and neural responses to emotional stimuli over several seconds (Lazarus & Alfert, 1964; Ochsner et al., 2004). These findings do not substantiate the characterization of reappraisal as a single decision that does not consume substantial cognitive resources, but instead demonstrate that reappraisal has a significant impact on stimulus encoding that may be expected to affect subsequent memory. Second, Richards and Gross (2000) found evidence for such an effect—reappraisal led to improved memory for highly arousing stimuli. These discrepancies between theory and findings indicate that the mechanism(s) linking effects of reappraisal on stimulus encoding and memory are not well-understood. There is thus a need for further investigation of the psychological processes by which this and other emotion regulation strategies influence memory.

The study reported here featured two experiments designed to test a new hypothesis—that effects of emotion regulation on memory reflect strategic influences on stimulus elaboration (Craik & Lockhart, 1972). Experiment 1 was designed to pit this formulation against a competing hypothesis—namely, that emotion regulation strategies influence memory via effects on emotional arousal. At encoding, participants used reappraisal to enhance and decrease responses to unpleasant and neutral pictures via mental imagery. Importantly, on trials featuring unpleasant pictures it was expected that while both the enhance and decrease cues would lead to significant amounts of stimulus elaboration, emotional arousal would be increased on enhance trials but reduced on decrease trials (Ochsner et al., 2004). Therefore, similar levels of recall for pictures presented on unpleasant enhance and decrease trials would support the stimulus elaboration hypothesis, while greater recall for unpleasant pictures from enhance versus decrease trials would support the arousal hypothesis.

As a second test of the stimulus elaboration hypothesis, in Experiment 2 the decrease cue was replaced with a suppress cue that directed participants to inhibit emotion-expressive behavior. Although both the decrease and suppress cues instruct participants to down-regulate aspects of their emotional responses, expressive suppression does not encourage significant stimulus elaboration because participants must attend primarily to their physiology. Therefore, the stimulus elaboration hypothesis predicts good recall for unpleasant pictures from decrease trials (Experiment 1), but poor recall for unpleasant pictures presented on suppress trials (Experiment 2).

Two additional design features facilitated interpretation of results. First, both experiments featured tests of explicit and implicit memory (free recall and perceptual priming, respectively). Previous studies of emotion regulation and memory have focused exclusively on explicit memory, which involves conscious recall of encoded information and is supported by medial temporal lobe structures (Squire, 1992). However, it is possible that emotion regulation may also affect implicit memory, which does not depend upon conscious recall and is instead demonstrated through changes in behavior (Graf, 1994; LaBar & Cabeza, 2006). Importantly, implicit memory tests are generally insensitive to variations in elaborative encoding (e.g., Jacoby & Dallas, 1981, but see Roediger, Gallo, & Geraci, 2002). Therefore, the stimulus elaboration hypothesis predicts no effect of emotion regulation strategies on the implicit memory test (perceptual priming). Conversely, observing effects of emotion regulation on the implicit test would argue against this hypothesis.

Second, both experiments featured unpleasant and neutral pictures, and regulation cues were fully counterbalanced with both picture types. Many previous studies of emotion regulation have either presented only emotional stimuli (e.g., Bonanno et al., 2004) or have not fully counterbalanced regulation cues with emotional and nonemotional stimuli (e.g., presenting neutral pictures solely on no-regulation trials) (e.g., Jackson et al., 2000). These approaches confound emotion elicitation and emotion regulation, making it difficult to determine whether results specifically reflect modulation of emotions or are simply due to cue-driven changes in cognitive processing which may be emotion-independent. To address this issue, we developed regulation instructions that could be used on both unpleasant and neutral trials. In this way, we could dissociate general strategic effects (common across unpleasant and neutral trials) from effects specific to trials featuring emotional stimuli (unpleasant pictures).

Specific predictions regarding recall were developed by considering the degree of stimulus elaboration required by each strategy (Craik & Lockhart, 1972). Reappraisal is characterized by transformation of stimulus representations (Gross, 1998b), which generally implies significant stimulus elaboration. In particular, we predicted that increasing the personal relevance of stimuli (enhance) via mental imagery would support good recall across picture types. However, because unpleasant images readily attract attention while neutral images do not (Lang, Bradley, & Cuthbert, 1997), we hypothesized that more cognitive processing would be required to decrease the impact of unpleasant pictures as opposed to neutral pictures, leading the effects of the decrease cue on recall to vary by picture type. Therefore, we predicted a Picture Type × Cue interaction for recall data in Experiment 1. By contrast, inhibiting emotional expressions requires monitoring of facial musculature and diverts attention away from stimuli (Richards & Gross, 2000), encouraging minimal stimulus elaboration. In addition, Richards and Gross found that expressive suppression impaired memory equivalently across low- and high-arousing slide sets. Thus, we predicted that recall in Experiment 2 would be characterized by a main effect of cue (*enhance* > *suppress*), but no Picture Type × Cue interaction. Because we hypothesized that emotion regulation would influence memory via strategic effects on stimulus elaboration, we predicted no effects of regulation on perceptual priming in either experiment (Jacoby & Dallas, 1981).

Experiment 1

Method

Participants

Forty-one healthy individuals participated. Two participants were excused because of drowsiness and data from two others were lost. The remaining 37 participants (25 females, 12 males) had a mean age of 23.

Stimuli

Ninety unpleasant and 90 neutral pictures were selected from the International Affective Picture Set (Lang, Bradley, & Cuthbert, 2001) and an in-house database (Dolcos et al., 2004). Unpleasant pictures primarily depicted acts of threat or violence, while neutral pictures primarily depicted people engaged in everyday activities. Normative mean (*SD*) valence (1 = unpleasant, 9 = pleasant) and arousal (1 = calming, 9 = exciting) ratings were 2.52 (0.66) and 6.11 (.80) for unpleasant pictures and 5.03 (.35) and 3.64 (.52) for neutral pictures. Pictures were divided into sets of 45 presented at encoding or as novel stimuli in the priming paradigm. *T* tests comparing encoding and novel sets (separately for unpleasant and neutral) revealed no differences on arousal or valence. Pictures were formatted as squares occupying approximately 18 degrees of visual angle, and mean luminance of pictures was adjusted to fall between 112.5 and 113.5 luminance units (*SD* between 62.5 and 63.5) using Adobe Photoshop CS software (Adobe Systems, Inc.; San Jose, CA).

Encoding Procedure

Paradigm. The experiment was conducted using Presentation software (Neurobehavioral Systems, Inc., San Francisco). Encoding trials (see Figure 1) began with presentation of a reappraisal cue—the word "ENHANCE," "LOOK," or "DECREASE"—centered horizontally above fixation (duration: 1.5 s). Cues were followed by an unpleasant or neutral picture (4 s), which was replaced by a gray screen (8 s). This screen was followed by valence and arousal rating screens (1.5 s each). On the valence screen, the question "Unhappy-Happy?" was displayed and Self-Assessment Manikins (SAMs; Bradley & Lang, 1994) depicting increasingly positive facial expressions were presented below the numerals 1 to 5 (1 = very unhappy, 3 = neutral, 5 = very happy). On the arousal screen, the question "Calm-Excited?" was displayed and SAMs depicting increasing levels of arousal were presented below the numerals 1 (*very calm*) to 5 (*very excited*). Participants responded by rating their subjective experience (at the end of each trial) for valence and arousal. The arousal rating screen was followed by a 1 s intertrial interval.

Three different sets of picture-cue pairings were generated for use at encoding such that every picture was presented with each of the three cues an approximately equal number of times across participants. For all three sets of picture-cue pairings, presentation order was initially randomized and then modified according to the following rule: no more than three consecutive presentations of a particular cue or picture type were allowed. This rule was used in order to prevent formation of either particular mental sets (if several cues of the same type were presented consecutively) or mood effects (if several unpleasant pictures were presented consecutively). Once finalized, stimulus presentation orders for each picture-cue pairing were divided into six blocks of 15 trials for use in the encoding session. Block order was randomized across participants. A practice session of 12 encoding trials was administered.

Instructions. Participants were instructed to modulate their responses to pictures according to reappraisal cues, as in a previous report (Ochsner et al., 2004). In response to the look cue, participants were to let reactions elicited by pictures unfold naturally. In other words, the look cue signaled a "no regulation" trial. In response to the enhance cue, participants were to increase the personal relevance of pictures via mental imagery, vividly imagining themselves or a loved one as the central figure in the scene depicted and imagining how they would feel

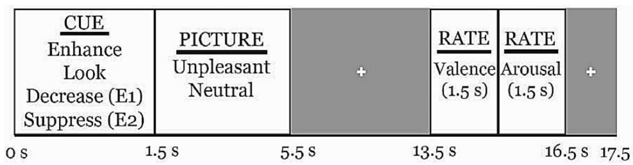

Figure 1. Trial structure and timing. Individual trials began with presentation of one of three regulation cues, followed by an unpleasant or neutral picture, a gray screen, valence and arousal rating screens, and a 1 s intertrial interval.

in such a scenario. In addition, they were to use this strategy to amplify any emotion(s) that might be elicited by pictures. In response to the decrease cue, participants were to intensify their sense of subjective distance from the content of pictures by imagining being present at scenes (so that both enhancing and decreasing would require mental imagery), but regarding them from a detached perspective, as though what was depicted involved strangers and was remote from their concerns. Finally, they were to use this strategy to de-emphasize any emotion(s) that might be elicited by pictures.

Importantly, participants were told to expect to view some pictures that elicited little or no emotion. However, it was emphasized that the imagery instructions provided by cues should be followed on every trial. In other words, when presented with the enhance and decrease cues, participants should increase and reduce the personal relevance of pictures accordingly, regardless of the pictures' emotional content or lack thereof. These instructions were intended to ensure that cues would be followed on trials featuring both picture types, allowing for investigation of potentially emotion-independent effects of reappraisal expected to be common across unpleasant and neutral trials.

For example, the enhance cue might be paired with a neutral picture depicting people meeting in a business setting. In response to the cue, participants were expected to mentally place themselves in the meeting as an active participant, imagining what they would hear, see, smell, and do in such a scenario. By contrast, on another trial the enhance cue might be paired with an unpleasant picture depicting a badly burned individual in a hospital bed. In response to the cue, participants were expected to mentally place themselves either in the hospital bed or at the bedside (i.e., imagining either themselves or a loved one as the wounded individual). They were again expected to imagine what they would hear, see, smell, and do in such a scenario. Thus, regardless of what type of picture was presented, on enhance trials participants were to increase the personal relevance of pictures by using mental imagery and focusing on their sensory perceptions. Accordingly, memory effects sensitive to these cognitive processes should be evident across both unpleasant and neutral trials. However, we expected that using imagery in this way would naturally augment emotional responses elicited by unpleasant pictures, while no substantial emotion effects were expected on neutral trials because the neutral pictures depicted unarousing scenarios. Thus, we predicted that this design would also reveal emotion-specific effects of emotion regulation.

One potential concern was that participants might interpret enhance cues presented in conjunction with neutral pictures as an instruction to generate some emotional response, which was not intended. To avoid this problem, during the practice session it was repeatedly emphasized that participants should focus primarily on manipulating the personal relevance of pictures and should not generate emotions if pictures did not elicit them in the first place. Finally, participants were instructed to regulate their responses while pictures were on-screen and during the 8 s gray screen period following picture offset. This long duration post-picture period was designed to encourage participants to regulate their emotions by focusing on their feelings and perceptions, rather than by selectively attending to certain picture elements, and is consistent with our prior psychophysiological work using this paradigm (Dillon & LaBar, 2005).

Memory Tests

Perceptual identification. A spatial attention task lasting approximately one hour was administered between encoding and memory testing. This task was followed by a perceptual identification task, modified from LaBar et al. (2005), in which pictures were initially presented subliminally and exposure duration was increased until an indoor/outdoor categorization was made. During this task, the 90 pictures studied at encoding and 90 novel pictures (half unpleasant/half neutral) were presented. Indoor/outdoor judgments were made by pressing either of two buttons on a keyboard, and priming was inferred when participants required shorter exposure durations to categorize studied pictures versus novel pictures.

The task was described as an investigation of picture perception—no mention of memory was made. Participants were informed that pictures would flash onscreen, and that the exposure duration would increase with each flash. Pictures were initially presented at a subliminal duration (17 ms). Exposure durations were then increased by 17-ms increments until the participant made a judgment or until a maximum exposure duration (306 ms) was reached. The maximum exposure duration was reached on less than 1% of trials. Scenes were backward masked for 100 ms following each exposure. Masks were the same size as pictures and consisted of 96 rectangular elements clipped from various unpleasant and neutral pictures. After the mask (before the subsequent picture exposure), a gray screen was shown for 150 ms.

Speed and accuracy were emphasized equally, and a practice session of 10 perceptual identification trials was administered. Following practice, three blocks of 60 pictures were presented. Stimulus order was pseudorandomized as in the encoding session (e.g., no more than three unpleasant or neutral pictures were presented consecutively), and block order was randomized across participants. Exposure duration was recorded for every picture presentation up until category judgment. These data were then summed for each picture presented to a participant during the priming test in order to get cumulative exposure duration. For each participant, mean cumulative exposure durations were then calculated by picture type and cue and entered into repeated measures analysis of variance (ANOVAs).

Free recall. Following perceptual identification, participants were presented with a surprise free recall test (i.e., incidental memory). They were given 15 minutes to write descriptions for as many pictures as could be recalled from encoding, and were instructed to provide enough detail so that an outsider could identify each picture being described and differentiate it from similar pictures, according to criteria established by Dolcos and Cabeza (2002). Only picture descriptions that could be identified and differentiated were scored as correct.

Free recall data from Experiments 1 and 2 were scored by the third and second author, respectively, after each had been trained to use criteria described in Dolcos and Cabeza (2002). To assess reliability, recall data from five participants in each experiment were also scored by the first author. Acceptable levels of agreement between scorers were obtained (91% for Experiment 1, 92% for Experiment 2), and judgments made by the primary scorers were retained for analysis. For each participant, mean percent correct recall was calculated by picture type and cue and entered into repeated-measures ANOVAs.

Results

Valence and Arousal Ratings

Valence and arousal ratings are presented in Figure 2, and statistics from analysis of ratings are presented in Table 1. Valence ratings revealed that participants experienced more unpleasant emotion(s) on trials featuring unpleasant as opposed to neutral pictures. The Picture Type × Cue interaction was also significant. For unpleasant pictures, emotional experience was most unpleasant on enhance trials, intermediate on look trials, and least unpleasant on decrease trials (all *p*s $< .05$). For neutral pictures, emotional experience was more pleasant on trials featuring the enhance cue than on trials featuring look or decrease cues (*p*s $<$ .05), which did not differ.

Arousal ratings revealed that participants were more aroused on trials featuring unpleasant than neutral pictures. The main effect of cue was also significant. Participants were most aroused on enhance trials and least aroused on decrease trials, with look trials yielding an intermediate response (all *p*s $< .05$). The Picture Type × Cue interaction was also significant, apparently due to a larger arousal difference across look versus decrease trials for unpleasant as opposed to neutral pictures (see Figure 2). However, follow-up tests revealed that ratings differed significantly across all three cues for both unpleasant and neutral trials (all *p*s $< .05$), indicating that arousal was modulated effectively by both the enhance and decrease cues regardless of picture type. In summary, unpleasant pictures elicited negative emotion and the enhance and decrease cues modulated valence and arousal.

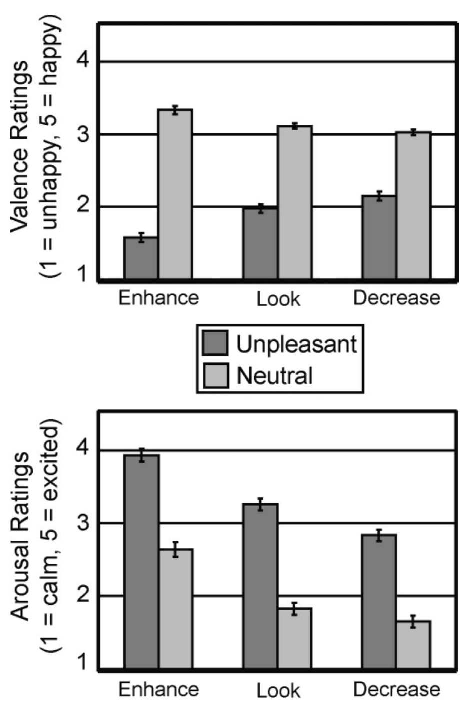

Figure 2. Mean valence (top panel) and arousal (bottom panel) ratings by picture type and reappraisal cue (Experiment 1). Unpleasant pictures were rated as more negative and more arousing than neutral pictures. As expected, arousal and valence ratings were modulated by reappraisal.

Perceptual Identification

Analysis of cumulative exposure duration required to categorize pictures studied at encoding revealed no effect of reappraisal cue, $F(2, 72) < 1$, and no Picture Type × Cue interaction, $F(2, 72) = 1.21$, $p = .30$, indicating that emotion regulation did not affect perceptual priming. We thus collapsed across cues and computed mean "studied" scores for unpleasant and neutral pictures (see Table 2). These were entered into a repeated-measures analysis of variance (ANOVA) with picture type and priming status (studied, novel) as factors. There was a significant main effect of priming, $F(1, 36) = 14.57$, $p < .0005$, due to the fact that cumulative exposure duration was shorter for studied than novel pictures. There was also a main effect of picture type, $F(1, 36) = 78.69$, $p < .0001$. Participants required longer exposures to classify unpleasant versus neutral pictures. The Picture Type × Priming interaction was not significant, $F(1, 36) < 1$.

Free Recall

Recall data are presented in Figure 3, and statistics from analysis of free recall are presented in Table 3. Participants recalled more unpleasant than neutral pictures. The Picture Type × Cue interaction was also significant. Consistent with the stimulus elaboration hypothesis, recall was superior for unpleasant pictures presented on enhance and decrease trials relative to look trials, yielding a significant quadratic trend ($p < .03$) across enhance, look, and decrease scores. The enhance versus look comparison was significant ($p < .03$), while the decrease versus look comparison was not significant ($p = .11$). For neutral pictures, recall was best for pictures from enhance trials and worst for pictures from decrease trials ($p < .003$), with recall for pictures from look trials in-between, yielding a significant monotonic trend ($p < .003$) across enhance, look, and decrease scores. Recall of pictures from enhance and decrease trials did not differ significantly from recall of pictures from look trials (*p*s $> .10$).

Summary

Both valence and arousal were modulated by reappraisal. Critically, recall was characterized by a Picture Type × Cue interaction. For both picture types, recall was best on enhance trials. By contrast, unpleasant pictures from decrease trials tended to be well-recalled while neutral pictures from decrease trials tended to be poorly recalled. There were no regulation effects on perceptual priming.

The free recall results were consistent with predictions, and the finding that Unpleasant pictures from enhance and decrease trials were similarly well-recalled despite significant differences in self-reported arousal (and valence) supports the stimulus elaboration hypothesis. The finding of no effect of regulation cues on implicit memory is also consistent with this hypothesis.

To further test this account, in Experiment 2 we replaced the decrease cue with a suppress cue that directed participants to inhibit emotion-expressive behavior. Although both the decrease and suppress cues instruct participants to down-regulate emotional experience, the different psychological processes engaged by reappraisal and expressive suppression were expected to have different consequences for memory. Specifically, because expressive

Table 1
Main Effects and Interactions for Valence and Arousal Ratings

	Experiment 1				Experiment 2			
	df	*F*	*p*	η^2_p	*df*	*F*	*p*	η^2_p
Valence								
Picture	1, 36	492.79	.0001	0.93	1, 35	316.39	.0001	0.90
Cue	2, 72	5.41	.01	0.13	2, 70	0.49	.61	0.01
Picture × Cue	2, 72	58.82	.0001	0.62	2, 70	18.92	.0001	0.35
Arousal								
Picture	1, 36	215.36	.0001	0.86	1, 35	124.36	.0001	0.78
Cue	2, 72	125.02	.0001	0.78	2, 70	70.75	.0001	0.67
Picture × Cue	2, 72	3.18	.05	0.08	2, 70	0.83	.44	0.02

Note. Results of follow-up comparisons are reported in the text.

suppression directs attention away from stimulus encoding we expected poor recall of both unpleasant and neutral pictures presented on suppress trials, consistent with previous findings (e.g., Richards & Gross, 1999, 2000).

Experiment 2

Method

Participants

Thirty-seven healthy individuals participated. One individual withdrew due to the aversive nature of the unpleasant pictures. The remaining 36 participants (18 females, 18 males) had a mean age of 21.

Stimuli and Procedure

The stimuli and procedure were unchanged in Experiment 2, with two exceptions. First, the decrease cue was replaced with a suppress cue (see Figure 1). Second, a strategy questionnaire (described below) was administered after encoding.

Instructions. Instructions regarding the enhance and look cues were unchanged. In response to the suppress cue, participants were to inhibit emotional expressions elicited by pictures. They were told that when viewing pictures presented after suppress cues, they should "behave so that a person watching you would not know you were feeling anything at all" (Gross & Levenson, 1993).

Table 2
Perceptual Priming by Picture Type and Priming Status

Picture type	Priming status	Mean (*SD*) cumulative exposure duration (ms)
Experiment 1		
Unpleasant	Studied	422 (116)
	Novel	469 (176)
Neutral	Studied	347 (81)
	Novel	395 (133)
Experiment 2		
Unpleasant	Studied	442 (104)
	Novel	465 (119)
Neutral	Studied	384 (90)
	Novel	408 (101)

Strategy questionnaire. Videotaping has shown that the suppress instructions used here reduce emotion-expressive behavior (Gross & Levenson, 1993). However, it was not possible to obtain video recordings in this experiment. Instead, after encoding a strategy questionnaire was administered to assess compliance with instructions. Participants rated the extent to which they responded to cues by inhibiting emotional facial expressions or by imagining themselves or loved ones in pictures. They also rated their success at inhibition and imagery, and estimated how much they attended to pictures presented after each cue.

Results

Valence and Arousal Ratings

Valence and arousal ratings are presented in Figure 4. Valence ratings indicated that participants experienced more unpleasant emotion on trials featuring unpleasant as opposed to neutral pictures (see Table 1). The Picture Type × Cue interaction was also significant. For unpleasant pictures, emotional experience was more unpleasant on enhance trials than on look or suppress trials (*p*s $< .05$), which did not differ. For neutral pictures, emotional experience was more pleasant on trials featuring the enhance cue than on trials featuring look or suppress cues (*p*s $< .05$), which did not differ.

Arousal ratings revealed that participants were more aroused on trials featuring unpleasant as opposed to neutral pictures. There was also a main effect of cue. Participants were most aroused on enhance trials and least aroused on suppress trials, with look trials in-between (all *p*s $< .05$). The Picture Type × Cue interaction was not significant, indicating that arousal was modulated similarly by emotion regulation regardless of picture type.

In summary, the enhance cue modulated valence and arousal as in Experiment 1. In contrast to the decrease cue, the suppress cue did not effectively modulate unpleasant emotional valence, although it modulated arousal. The differential effects of these strategies on valence replicates past work demonstrating that reappraisal modulates unpleasant emotional experience more effectively than suppression (Gross, 1998a).

Strategy Questionnaire

Data from the strategy questionnaire support the efficacy of the regulation manipulations (see Table 4). Critically, suppress cues

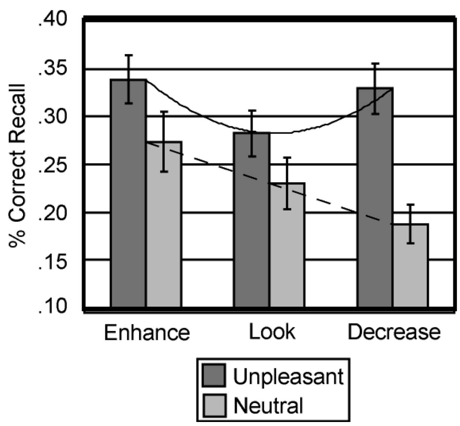

Figure 3. Free recall data from Experiment 1. A Picture Type × Cue interaction was observed. Note that for unpleasant pictures, recall tended to be better for pictures from enhance and decrease trials. By contrast, for neutral pictures recall was best for pictures from enhance trials and worst for pictures from decrease trials. Across enhance, look, and decrease recall scores, a significant quadratic trend was observed for unpleasant pictures (solid line: $p < .03$) and a significant linear trend was observed for neutral pictures (dashed line: $p < .003$).

elicited inhibition of emotional facial expressions to a greater extent than look or enhance cues. By contrast, enhance cues elicited mental imagery to a greater extent than look or suppress cues. Participants reported paying more attention to pictures on enhance trials than on look or suppress trials.

Perceptual Identification

Analysis of cumulative exposure duration required to categorize pictures studied at encoding revealed no effect of regulation cue, $F(2, 70) < 1$, and no Picture Type × Cue interaction, $F(2, 70) < 1$, indicating that emotion regulation did not affect perceptual priming. However, there was a significant main effect of priming, $F(1, 35) = 30.45$, $p < .0001$, due to the fact that cumulative exposure duration was shorter for studied than novel pictures (see Table 2). There was also a main effect of picture type, $F(1, 35) = 73.33$, $p < .0001$. Participants required longer cumulative exposures to classify unpleasant versus neutral pictures. The Picture Type × Priming interaction was not significant, $F(1, 35) < 1$. These results replicate Experiment 1.

Free Recall

Participants recalled more unpleasant than neutral pictures (see Figure 5). The main effect of regulation cue was significant (see Table 3). Recall was better for pictures from *enhance* trials than for pictures from suppress trials ($p < .006$), yielding a significant monotonic trend across enhance, look, and suppress scores ($p < .006$). There was a trend ($p = .09$) for better recall of pictures from enhance versus look trials, but the look versus suppress comparison was not significant ($p = .26$). The Picture Type × Cue interaction was not significant, indicating that encoding of unpleasant and neutral pictures was similarly affected on enhance and suppress trials.

Summary

In contrast to reappraisal, expressive suppression did not modulate unpleasant emotional valence. Critically, recall performance was characterized by a main effect of cue. Across picture types, recall of pictures from enhance trials was better than for pictures from suppress trials. This result replicates previous research and is consistent with the proposal that expressive suppression yields low levels of elaborative encoding in conjunction with both high- and low-arousing stimuli. There were no regulation effects on perceptual priming, again consistent with the stimulus elaboration hypothesis.

Comparison of Recall Across Experiments 1 and 2

Two analyses directly compared the effects of emotion regulation on recall across experiments. First, recall of pictures from enhance and look trials was analyzed in a mixed ANOVA with experiment, picture type, and cue as factors. The main effect of cue was significant, $F(1, 71) = 9.48$, $p < .003$, $\eta^2_p = .12$, but the interaction terms were not (Fs < 1). Across experiments, recall was 4% better for pictures from enhance trials, regardless of picture type. For unpleasant pictures percentages were 34% (enhance) versus 30% (look), while for neutral pictures percentages were 26% versus 22% (effect of picture type, $p < .0001$).

Second, for each participant we subtracted percent correct recall on look trials from percent correct recall in the emotion regulation conditions, separately for unpleasant and neutral pictures. This procedure subtracts out the "no regulation" baseline (recall on look trials), thus normalizing the effects of regulation to baseline performance across participants and facilitating comparison across regulation conditions. This technique also simplifies comparison of results across experiments, since recall of pictures from look trials was higher in Experiment 2. Results are depicted in Figure 6.

For each experiment, data from these subtractions was analyzed via ANOVAs with picture type and regulation as factors. For Experiment 1, the Picture Type × Regulation interaction was significant, $F(1, 36) = 4.64$, $p < .04$, $\eta^2_p = .12$. For unpleasant

Table 3
Main Effects and Interactions for Recall

	Experiment 1				Experiment 2			
	df	*F*	*p*	η^2_p	*df*	*F*	*p*	η^2_p
Picture	1, 36	20.94	.0001	.37	1, 35	86.27	.0001	.71
Cue	2, 72	4.00	.02	.10	2, 70	4.13	.05	.10
Picture × Cue	2, 72	3.21	.05	.08	2, 70	0.55	.58	.01

Note. Results of follow-up comparisons are reported in the text.

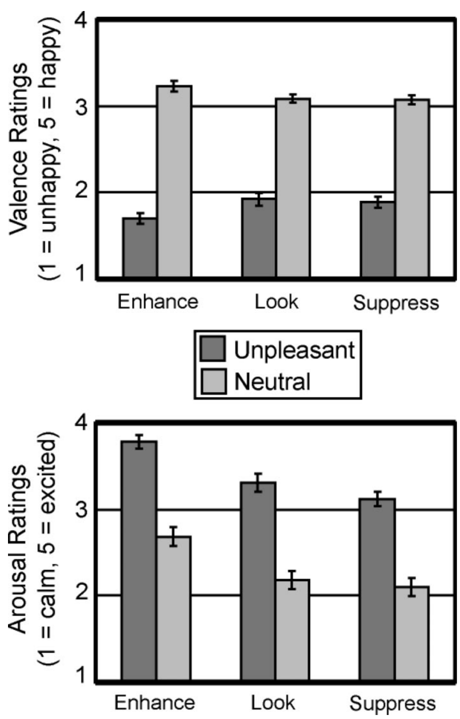

Figure 4. Mean valence (top panel) and arousal (bottom panel) ratings by picture type and regulation cue (Experiment 2). Unpleasant pictures were rated as more negative and more arousing than neutral pictures. As in Experiment 1, both arousal and valence were modulated on enhance trials. By contrast, valence was not modulated on suppress trials (relative to look trials).

pictures the effect of regulation was not significant ($p = .76$), because both the enhance minus look and decrease minus look subtractions yielded positive difference scores (6% and 5%, respectively). By contrast, for neutral pictures the effect of regulation was significant, $F(1, 36) = 10.10$, $p < .003$, $\eta^2_p = .22$, because the enhance minus look comparison yielded a positive score (4%) while the decrease minus look comparison yielded a negative score (−4%). For Experiment 2, only the main effect of regulation was significant, $F(1, 35) = 9.95$, $p < .003$, $\eta^2_p = .22$. Across unpleasant and neutral pictures, the enhance minus look subtraction yielded a positive score (3%), while the suppress minus look subtraction yielded a negative score (−2%). In summary, even after adjusting for variable performance on look trials, the main conclusions held: enhance cues supported recall across picture types, suppress cues impaired recall across picture types, and decrease cues supported recall of unpleasant pictures but impaired recall for neutral pictures.

Discussion

Emotion regulation had dissociable effects on explicit and implicit memory, affecting free recall but not perceptual priming. Across experiments, pictures from enhance trials were better recalled than pictures from look trials, regardless of picture type. The Picture Type × Cue interaction in Experiment 1 indicated that recall of pictures from decrease trials varied by picture type. Intriguingly, unpleasant pictures from decrease trials tended to be well-recalled, while neutral pictures from decrease trials tended to be poorly recalled. There was no Picture Type × Cue interaction in Experiment 2. Instead, the main effect of cue revealed that pictures from suppress trials were poorly recalled relative to pictures from enhance trials. Thus, dissociations were also found between strategies with respect to their consequences on recall.

This study extends previous work by demonstrating that using reappraisal to enhance the personal relevance of stimuli improves explicit memory, and by showing that emotion regulation strategies do not affect perceptual priming. However, several results were consistent with previous findings. Compared with performance in the enhance condition, expressive suppression impaired memory similarly for low-arousing (neutral) and high-arousing (unpleasant) stimuli. In addition, as in Richards and Gross (2000), using reappraisal to decrease the impact of stimuli improved explicit memory for high-arousing stimuli.

Results from the enhance and decrease conditions are inconsistent with the proposal that reappraisal does not require ongoing cognitive work and thus should not affect memory. Instead, reappraisal appears to have a significant impact on explicit memory. Collectively, results are consistent with the hypothesis developed in the Introduction—emotion regulation strategies affect memory by influencing stimulus elaboration. We propose that whether an unpleasant or neutral picture is presented, imagining oneself as the central figure in a scene (enhance) requires significant stimulus elaboration and supports recall, while focusing on inhibiting facial expressions (suppress) directs attention away from stimuli, does not promote stimulus elaboration, and yields poorer recall. In other words, the enhance and suppress cues lead to strategic effects on memory which cut across emotional and nonemotional stimulus categories. By contrast, effects of the decrease cue on recall were asymmetrical across unpleasant and neutral stimuli. We hypothesize that following the decrease cue on unpleasant trials requires effortful elaboration because unpleasant pictures automatically attract attention and elicit emotional arousal—gaining subjective distance from these pictures requires mentally transforming their impact. However, neutral pictures do not attract attention and do not elicit arousal; thus, the decrease cue is easily followed and significant stimulus elaboration is not encouraged. Consequently, encoding of neutral stimuli presented on these trials is poor.

The importance of stimulus elaboration in determining explicit memory effects is especially clear when the results from Experiment 2 are compared with results obtained by Bonanno and col-

Table 4
Inhibition of Emotional Facial Expressions, Use of Mental Imagery, and Attention During Emotion Regulation in Experiment 2

	Enhance	Look	Suppress
Inhibition: attempt	1.31 (1.83)$_a$	1.71 (1.79)$_a$	4.31 (1.71)$_b$
Inhibition: success	3.12 (1.58)$_a$	3.36 (1.56)$_a$	4.26 (1.36)$_b$
Imagery: attempt	4.94 (1.26)$_a$	1.66 (1.63)$_b$	0.91 (1.27)$_c$
Imagery: success	4.53 (1.40)$_a$	3.17 (1.56)$_b$	2.69 (1.40)$_b$
Attention to pictures	5.0 (0.91)$_a$	4.14 (1.38)$_b$	4.17 (1.10)$_b$

Note. Data are mean (*SD*) values. Ratings made using a 7-point Likert scale (0 = *not at all*; 6 = *a great deal*). Means in a row which do not share a subscript differ at $p < .05$.

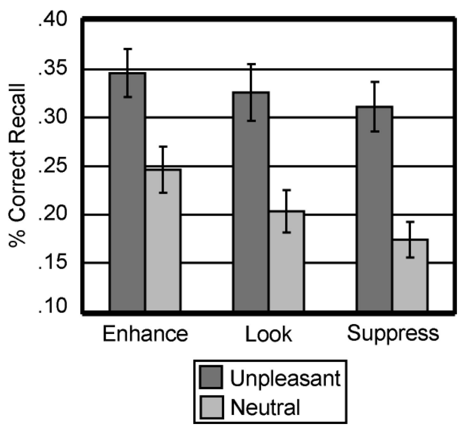

Figure 5. Free recall data from Experiment 2. A main effect of cue was observed. Across picture types, recall was better for pictures from enhance trials than for pictures from suppress trials.

leagues (2004). Using a within-participants design, Bonanno and colleagues instructed participants to enhance and suppress emotion-expressive behavior while viewing pleasant and unpleasant slides. Memory for slides presented in both the enhance and suppress conditions was impaired relative to memory for slides presented in a "just watch" condition. By contrast, in Experiment 2 of the present study, recall was better for pictures presented on enhance versus suppress trials. The critical difference between the two studies lies in the fact that in Bonanno et al. (2004), the enhance condition encouraged minimal stimulus elaboration, while in the present study, the enhance condition encouraged significant stimulus elaboration via reappraisal. In summary, these results demonstrate that the process by which emotions are regulated critically determines explicit memory performance. Other factors, including regulatory goals (to increase or reduce emotions), appear to be of secondary importance.

The Role of Emotional Arousal

Experiment 1 was designed to examine two possible mechanisms by which emotion regulation strategies might affect memory: stimulus elaboration versus arousal modulation. The finding of equivalent recall for unpleasant stimuli presented on enhance and decrease trials, despite significant differences in self-reported arousal (and valence) across these trials, supports the stimulus elaboration hypothesis. However, it is important to note that the effects of stimulus elaboration appear to be superimposed upon the well-known modulation of explicit memory by arousal. In both experiments, recall was better for unpleasant than neutral pictures, consistent with many studies demonstrating that emotionally arousing material is better remembered than nonarousing material and presumably reflecting neurohormonal modulation of medial temporal lobe (MTL) memory structures by the amygdala (reviewed in LaBar & Cabeza, 2006). In addition, across both experiments recall of unpleasant pictures from every condition (enhance, look, decrease, and suppress) was numerically superior to recall of neutral pictures from any condition, indicating that regulation-based modulation of explicit memory was never strong enough to counteract or supersede the effects of arousal. Therefore, we speculate that the observed pattern of recall results reflects the operation of two interacting processes. First, emotional arousal triggers neurohormonal modulation of MTL memory structures to yield enhanced subsequent memory performance. Second, emotion regulation strategies are deployed and serve to alter stimulus representations. By affecting stimulus elaboration, regulation strategies modulate explicit memory—but these modulations piggyback upon the main effect of emotional arousal.

For example, in Experiment 1 recall of unpleasant pictures from every condition is numerically superior to recall of neutral pictures from any condition (see Figure 3), leading to a robust main effect of picture type (see Table 3) that reflects the contribution of emotional arousal. However, considering the unpleasant picture data alone, arousal was highest on enhance trials and lowest on decrease trials, yet recall tended to be similar for unpleasant pictures from enhance and decrease trials (Figures 3 and 6). This pattern of results reflects the effects of emotional arousal (unpleasant $>$ neutral), plus regulation-based, strategic influences on stimulus elaboration (unpleasant enhance $=$ unpleasant decrease). In addition, these results support the conclusion that although using reappraisal to enhance and decrease the impact of stimuli yields differential effects on arousal, valence, and amygdala activity (Ochsner et al., 2004), the cognitive processes underlying reappraisal (in both the enhance and decrease conditions) support recall of unpleasant pictures to a similar degree.

Alternative Perspectives: Transfer-Appropriate Processing and Self-Referential Memory

Previous studies of emotion regulation have explained their findings by referring to differences between antecedent- and response-focused regulation strategies (e.g., Richards & Gross, 2000). We have attempted to extend this research by linking emotion regulation to strategic differences in stimulus elaboration,

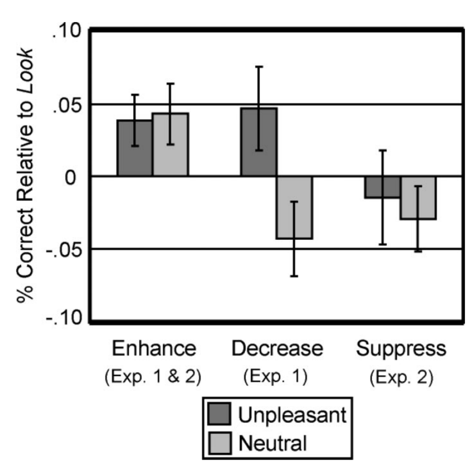

Figure 6. Comparison of emotion regulation strategy effects on free recall. Data illustrate change in percent correct relative to percent correct on look trials. Data from the enhance condition is averaged across Experiments 1 and 2. Pictures from enhance trials are well-recalled; pictures from suppress trials tend to be poorly recalled. Recall of pictures from decrease trials varies by picture type: unpleasant pictures from decrease trials are well-recalled, while neutral pictures from decrease trials are poorly recalled.

and results appear consistent with the stimulus elaboration hypothesis. However, it is important to acknowledge two important alternative perspectives on the data reported here, as well as on relationships between emotion regulation and memory more generally.

First, it may be useful to examine emotion regulation strategies from the perspective of transfer-appropriate processing (TAP; Roediger et al., 2002). Early demonstrations of superior memory for words processed for meaning versus words processed for phonemic or orthographic features led to the conclusion that "deep" processing always yielded better memory than "shallow" processing (Craik & Lockhart, 1972; Craik & Tulving, 1975). However, research on encoding specificity (Tulving & Thompson, 1973) and TAP (Morris, Bransford, & Franks, 1977) revealed that the match between processes engaged at encoding and retrieval is a critical determinant of memory performance, such that ostensibly shallow encoding can lead to robust memory if similar processes are recruited during encoding and retrieval. TAP theorists have since organized encoding and retrieval processes into two broad categories—conceptual and perceptual—and have argued that conceptual encoding manipulations affect performance on conceptual memory tests (including free recall), whereas perceptual encoding manipulations affect performance on perceptual memory tests (Roediger & Blaxton, 1987; Roediger, Weldon, & Challis, 1989). On this argument, emotion regulation strategies may be conceptual manipulations that affect conceptual but not perceptual tests, consistent with the observed effects of reappraisal and expressive suppression on free recall but not perceptual priming. This conceptualization is both consistent with and somewhat more specific than the current hypothesis. One way to test it would be to determine if emotion regulation strategies affect performance on conceptual implicit tests, as would be predicted by TAP.

Second, it is important to consider the possibility that results from the enhance and decrease conditions may reflect self-referential memory effects. The self-referential memory effect refers to the fact that items encoded in relation to the self are typically very well-recalled (for meta-analysis, see Symons & Johnson, 1997). In particular, several studies have demonstrated that judging trait adjectives in terms of how well they describe the self leads to better recall than processing the adjectives for meaning (e.g., Rogers, Kuiper, & Kirker, 1977), a notable result since meaning judgments were the first encoding tasks used to promote deep processing in the levels-of-processing framework. In addition, recent neuroimaging work (Macrae, Moran, Heatherton, Banfield, & Kelley, 2004) has shown that memory for self-referential adjectives is supported by medial prefrontal cortex (PFC) regions implicated in self-referential processing but not usually recruited during more standard elaborative encoding tasks (Gusnard, Akbudak, Shulman, & Raichle, 2001; Kelley et al., 2002). This result suggests that self-referential memory effects may differ in important ways from more general effects of stimulus elaboration.

Currently, the degree to which reappraisal and other forms of emotion regulation overlap with self-referential processing is unclear. However, using reappraisal to enhance the personal relevance of stimuli certainly involves self-referential processing, and indeed using reappraisal to vary the personal relevance of stimuli activates medial PFC (Ochsner et al., 2004). These results have led some researchers to question whether self-referential processing is one way to regulate emotions, or whether self-referential processing is a basic process that underlies emotion regulation (Northoff, 2005). The finding of improved recall for stimuli presented on enhance trials thus seems consistent with a self-referential memory effect. However, the self-referential memory literature—which has generally not examined emotion regulation and has primarily studied memory for words—does not lead to clear predictions regarding recall for stimuli from decrease trials. Specifically, it is unclear whether using reappraisal to decrease the personal relevance of stimuli should lead to improved memory because concepts related to self may be activated on these trials or, rather, worse memory because the goal on these trials is to *not* relate the stimuli to self.

One possibility is that the argument made earlier for asymmetrical use of stimulus elaboration across unpleasant/decrease trials and neutral/decrease trials also applies to self-referential processing: unpleasant pictures, because they are arousing and command attention, may be immediately regarded as self-relevant to a greater extent than neutral pictures. If so, using reappraisal to decrease responses on unpleasant trials would presumably activate self-knowledge to a greater extent than using reappraisal to decrease responses on neutral trials, potentially giving rise to the pattern of recall results observed in Experiment 1. Clearly, disentangling the relative roles played by self-referential processing and more general forms of stimulus elaboration in reappraisal is an important goal for future work.

Limitations and Future Directions

In addition to the possible contributions of TAP and self-referential processing, this study had several limitations. For instance, no emotional benefit was observed for perceptual priming, which may have limited our ability to identify effects of emotion regulation on implicit memory. Using a similar task, we previously observed a benefit of emotion on perceptual priming (LaBar et al., 2005). However, in our previous report participants made a valence categorization during the priming test phase, which may have facilitated detection of an emotion effect. In the current research an indoor/outdoor task was used and no emotional benefit on priming was observed. Note, however, that an emotion effect was identified—across both Experiments 1 and 2, participants took longer to classify unpleasant pictures. This effect—which is consistent with previous research (LaBar et al., 2005) and has been attributed to perceptual defense (Bruner, 1992; Erdelyi, 1974)—could potentially have been modified by emotion regulation but was not, supporting our conclusion of dissociable effects of regulation on explicit versus implicit memory. Nonetheless, future experiments should determine whether emotion regulation affects performance on other tests of implicit memory.

Furthermore, no measures of effort or time-on-task were obtained, and it is conceivable differences in reappraisal effort across unpleasant and neutral trials may have contributed to the asymmetrical results from the decrease condition in Experiment 1. However, it should be noted that a simplistic time-on-task account (e.g., regulation strategies which take longer yield better explicit memory) cannot explain the results obtained in this or other studies of emotion regulation and memory, since expressive suppression—which requires participants to monitor their physiology for the entire duration of their emotional response—consistently leads to explicit memory decrements. On a related note, results from the strategy questionnaire (Experiment 2) indicated that participants paid more attention to pictures presented on enhance trials than to pictures from look or suppress trials, raising the possibility that results reflect differential use of attention across conditions. We suggest that potential differences in attention or effort across conditions would stem from differences in elaborative encoding (and hence would support our primary hypothesis), but future studies should include additional measures of effort and attention in order to determine their contributions to task performance.

One possible shortcoming is that the perceptual priming task may have influenced free recall, since pictures presented at encoding were presented a second time in the priming task. However, the opposite effects of emotion and emotion regulation observed across the two memory tests argues against this possibility. Emotion did not benefit priming, and priming was not affected by emotion regulation; by contrast, emotion improved free recall, and free recall was significantly affected by emotion regulation. This suggests that priming exerted minimal effect on explicit memory. This may be due in part to the choice of explicit memory test—free recall (which involves no retrieval cues) might be less sensitive to influence by the priming task than recognition or cued recall (which involve retrieval cues similar or identical to the pictures themselves).

Another shortcoming is that pleasant pictures were not presented, limiting the ability to make strong claims regarding the contributions of valence-related mechanisms to the observed results. Most research on emotion regulation has focused on negative affect, given its relevance for mental health. To provide a broader account, future research should include positive stimuli and should examine whether emotion regulation effects on memory are better understood in terms of dimensional or categorical theories of emotion. Future work might also present decrease and suppress cues in a single experiment, which would allow for a direct, within-participants comparison of the memory effects of these two regulation strategies. If such an approach is taken, it may be valuable to retain enhance cues in the design, as participants might adopt a different mental set in an experiment featuring only down-regulation cues as opposed to one featuring both up- and down-regulation cues. Finally, in the current experiment participants were required to reappraise a variety of rapidly presented scenes, half of which were emotionally evocative. This design was effective, but it is unclear whether results will generalize to naturalistic settings where reappraisal is used voluntarily and perhaps at a slower pace. Therefore, continued research examining effects of reappraisal on memory in real-world environments is required (Richards & Gross, 2000).

Conclusion

The results of this study establish a dissociation between effects of emotion regulation on explicit and implicit memory, as well as between strategies with respect to effects on explicit memory. Across experiments, using reappraisal to enhance the personal relevance of stimuli improved recall, while attempting to suppress emotion-expressive behavior impaired recall. Recall of pictures paired with decrease cues varied according to the nature of the stimuli—unpleasant pictures from decrease trials were well-recalled, while neutral pictures from decrease trials were poorly recalled. The potent effects of reappraisal on recall are in line with findings from studies of stimulus encoding, which indicate that reappraisal substantially affects psychophysiological and neural responses (Lazarus & Alfert, 1964; Ochsner et al., 2004), but are less consistent with the proposal that reappraisal should have little to no effect on memory because of its role as an antecedent-focused strategy (Richards & Gross, 2000). Instead, the recall results support a simple hypothesis—that emotion regulation strategies affect explicit memory via influences on stimulus elaboration, much as traditional levels-of-processing manipulations do (Craik & Tulving, 1975). Future studies should be designed to test and refine this hypothesis. In addition, it will be valuable to extend this research to psychopathological conditions since these often feature both emotion dysregulation and memory deficits (Williams, Watts, MacLeod, & Mathews, 1988), and understanding the link between these two clinical features will advance knowledge of relationships among different forms of affective disorders.

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