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BRIEF REPORT

Affect Influences False Memories at Encoding: Evidence from Recognition Data

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Memory is susceptible to illusions in the form of false memories. Prior research found, however, that sad moods reduce false memories. The current experiment had two goals: (1) to determine whether affect influences retrieval processes, and (2) to determine whether affect influences the strength and the persistence of false memories. Happy or sad moods were induced either *before* or *after* learning word lists designed to produce false memories. Control groups did not experience a mood induction. We found that sad moods reduced false memories only when induced *before* learning. Signal detection analyses confirmed that sad moods induced prior to learning reduced activation of nonpresented critical lures suggesting that they came to mind less often. Affective states, however, did not influence retrieval effects. We conclude that negative affective states promote item-specific processing, which reduces false memories in a similar way as using an explicitly guided cognitive control strategy.

Keywords: emotion, cognition, false memory, processing styles, recognition

Visual illusions are phenomena that have been widely studied to reveal mechanisms of perception (Bach & Poloschek, 2001). Memory, like vision, is also subject to illusions. For example, people sometimes develop false memories about past events (Loftus, 2003). Like visual illusions, the false memory illusion may allow a glimpse of usually hidden underlying processes. The goal of the current study, therefore, was to use the false memory phenomenon as a window on how affect regulates learning and memory.

Both real and false memories are dependent upon how information is learned. Everyday cognition requires a constant interplay of perception and memory, involving both taking in new information from the senses and bringing to bear interpretations from memory (Neisser, 1976). Two processing, or learning, styles have been identified by cognitive psychologists that capture this interplay of perception and cognition: item-specific and relational processing (Brainerd & Reyna, 1998; Hunt & McDaniel, 1993). Item-specific processing involves encoding the unique features, elements, and distinctive qualities of incoming information, whereas relational processing involves encoding incoming stimuli in relation to each other and to concepts in memory. Prior research has established that both processing styles have functional and dysfunctional consequences for memory (Brainerd & Reyna, 1998; Hunt & McDaniel, 1993).

False Memory Paradigm

The Deese-Roediger-McDermott (DRM) false memory paradigm lures people to falsely recall items that were never presented (Roediger & McDermott, 1995). For this paradigm, lists of words are constructed so that each word is associated with a single, nonpresented word, referred to as the critical lure. For instance, the words bed, pillow, rest, and dream might be presented, but its related critical lure, *sleep*, is not. This nonpresented critical lure (sleep) is often falsely recalled. The mechanisms behind the false memory effect are well understood (Brainerd, Wright, Reyna, & Payne, 2002; Roediger, Watson, McDermott, & Gallo, 2001).

One prominent theory of the false memory effect is the Activation/Monitoring Framework (Roediger, Watson, et al., 2001). It contends that two processes, semantic activation and monitoring, account for the effect. The main proposal is that critical lures are activated automatically due to spreading activation during learning. Once lures come to mind, they are likely to be recalled unless prevented by a monitoring strategy (Roediger, Watson, et al., 2001). For instance, Gallo, Roediger, and McDermott (2001) tested whether false memories occur due to encoding or retrieval processes. To test this claim, participants were warned about the false memory effect either prior to or after learning DRM lists. When a warning is given prior to learning it can influence both encoding and retrieval processes, but a warning provided after learning influences only retrieval. False memories were reduced only when the warning was provided prior to learning, but warning instructions provided after learning had no impact on retrieval processes or the false memory effect. Therefore, the false memory effect can be reduced through encoding processes.

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Another way of reducing the false memory effect is by changing how people attend to and encode list items. The fuzzy-trace theory suggests that processing styles influence critical lure activation during learning (Brainerd et al., 2002). It specifies that there are two independent processing styles; verbatim and gist, which conceptually are similar to item-specific and relational processing styles, respectfully. Gist processing focuses attention on semantic relations, which activates critical lures. The subsequent activation of critical lures increases the likelihood of false memories. Verbatim processing, on the other hand, draws attention to the perceptual details of items, which reduces the activation of semantic relations. Having fewer activated critical lures in mind should reduce the likelihood for false memories. For example, Hege and Dodson (2004) explicitly shifted attention to perceptual details by presenting words in different fonts, thereby promoting an item-specific processing of list items. They found this manipulation reduced the false memory effect.

Affect and False Memories: Encoding Versus Retrieval

Just as people can explicitly guide how they process information, we suggest that affective cues can guide information processing as well. One approach, the affect-as-information hypothesis, holds that the affective reactions in task situations serve as information about anticipated outcomes, which then influences how one approaches the task. Affective cues that are experienced as task-relevant serve as a gate between relational and item-specific processing (Clore et al., 2001; Storbeck & Clore, 2005). Positive affect provides feelings of efficacy, which validates one's current orientation. Because relational processing is often the default style of processing, positive affect then validates such processing (Bless et al., 1996; Storbeck & Clore, 2008). In contrast, negative affect promotes feelings of inefficacy, which inhibits the tendency to use the usually dominant, relational style of processing. As a result, negative moods promote the nondominant item-specific style of processing (Clore & Storbeck, 2006; Storbeck & Clore, 2008).

Storbeck and Clore (2005) used a Deese-Roediger-McDermott false memory task to examine how affective states influence processing styles. We induced a positive or negative mood or no mood at all (control group). Experiment 1 demonstrated that the negative mood group recalled fewer critical lures compared to both the positive and control groups. Experiment 2 asked whether the effect observed in Experiment 1 was due to encoding processes. To examine this question we used an inclusion paradigm, which asks participants to write down both words they recalled as having been presented and words that came to mind but that had not been presented. The sad mood group recorded fewer total critical lures compared to the positive group, suggesting that negative affect had reduced critical lure activation during encoding.

However, several questions remain about the false memory effect observed in Storbeck and Clore (2005). First, Storbeck, and Clore (2005) did not examine the influence that retrieval strategies have on the false memory effect. Prior research has shown that sadness reduces people's confidence in their memory and often promotes a conservative response bias (e.g., Mienaltowski & Blanchard-Fields, 2005; Park & Banaji, 2000). Such sadness-induced retrieval influences are consistent with the data from Storbeck and Clore (2005) and therefore need to be ruled out. Second, each list was presented in less than 4 s, and it is unclear whether such affective influences are ephemeral, concerning only immediate working memory or durable, concerning long-term memory. Prior research supports that positive affect enhances verbal working memory compared to negative affect (Gray, 2001). Therefore, it is necessary to examine long-term consequences affect has on memory and false memories. The goal then was to isolate (1) whether affect has its influence on learning as well as memory or whether it moderates retrieval processes (e.g., sad mood introduces a conservative reporting bias) and (2) whether these processes are ephemeral or robust over a long delay.

Overview and Predictions

To answer the questions posed above, we induced mood states either prior to or after learning. Comparing the two allowed us to separate encoding and retrieval effects. When affect is induced prior to learning, the affective state can influence both encoding and retrieval processes. When affect is induced after learning, the affective state can influence only retrieval processes (see Gallo et al., 2001 for a similar methodology except with warning instructions). In addition, because a recognition test was used, signal detection analyses were performed to further assess whether affect influences activation of critical lures (assessed by the sensitivity measure A') or retrieval biases (assessed by the response bias measure B''; Fiedler, Nickel, Muehlfriedel, & Unkelbach, 2001; Schacter, Israel, & Racine, 1999; Snodgrass & Corwin, 1988; Wixted & Stretch, 2000). Finally, there was a 10-min delay for all conditions between learning and testing to assess long-term memory for critical lures.

We hypothesized that a sad mood induced prior to learning would reduce the false memory effect. As a result, we anticipated that this condition would have a reduced activation of related critical lures as assessed with A'. In addition, we expected that the reduced false memory effect by the sad mood condition would not reflect mood effects on retrieval. Therefore, we anticipated that when affect was induced after learning, the incidence of false memory would be similar across conditions. These predictions are in line with the general logic of the affect-as-information approach and with findings from Storbeck and Clore (2005).

Method

Participants

One hundred eighty-nine University of Virginia undergraduates participated to fulfill a course requirement.

Design

Participants were randomly assigned to one of six conditions, creating a 2 Induction Time (Before vs. After) $\times$ 3 Mood (Happy, Sad, and Control) between-participants design. The dependent variables were recognition and signal detection parameters (as described below). See Figure 1 for a graphical representation of the design.

Apparatus and Stimuli

Mood induction. Happy and Sad moods were induced by showing movie clips totaling 10 min in length. The Happy mood

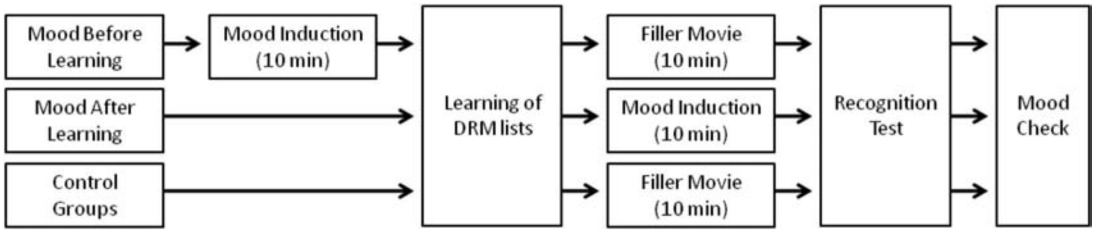

Figure 1. A schematic diagram for the sequential order and timing of each phase of the experiment.

group watched clips from *James Bond 007: For Your Eyes Only* and *Flashdance*. The Sad mood group watched clips from *Sophie's Choice* and *Gallipoli* (Martin, Ward, Achee, & Wyer, 1993; Sanna, 1998). The Control group began the study in their natural mood state.

False memory paradigm. Eighteen lists were chosen, and divided into two sets (A and B), each with nine lists (Roediger & McDermott, 1995). Half of the participants studied set A, the other half set B. Within each list, words were always presented in the same serial order (highest associated word to lowest associated word).

Filler task. Participants in the mood before learning and Control groups watched a 10-min clip from a dolphin documentary between the learning and testing phases. This clip served as a filler task to equate moods for each condition.

Recognition test. The recognition test consisted of 72 items, which consisted of the first, eighth, and tenth list items along with every critical lure. There were 27 presented items, 27 nonpresented foils, 9 related critical lures, and 9 unrelated critical foils. For the participants who studied set A, items from set B served as foils and vice versa.

Mood manipulation check. The mood manipulation check consisted of a single question asking participants how they felt during the mood induction phase. A 7-point scale was used with the anchors being "very unhappy" and "very happy."

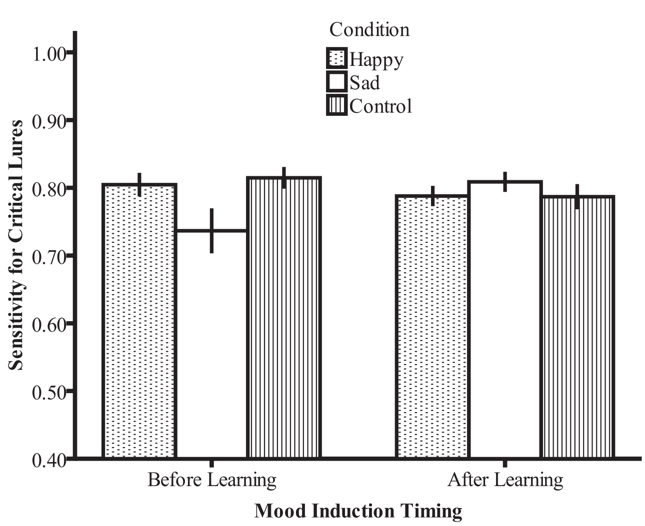

Figure 2. Mean sensitivity, A′, for distinguishing related critical lures from nonrelated critical lures. The bars represent 1 *SEM*.

Procedure

The experimenter provided instructions and told a cover story to disguise the purpose of the mood induction. Participants in the mood before learning condition began the experiment by viewing the mood induction films. The four remaining groups received no mood induction before learning. All participants were then randomly assigned to learning word list set A or B. The word lists were presented randomly. Each word was presented for 1 s, and after the last word, a computer-generated beep was presented. After the learning phase, all groups watched 10 min of film. Those participants in the *mood before learning condition* viewed the filler film, whereas those participants in the *mood after learning condition* viewed either the Happy, Sad, or filler (Control group) film. Next, each participant was given the recognition task. The words were randomly presented during the recognition test, and participants were asked to say whether or not each word had been presented during the learning phase. All participants then completed the mood check questionnaire.

Results

One individual from the Control group (mood after learning) was removed because the individual responded *yes* for all items on the recognition test.

Mood

Participants whose moods were not effectively manipulated were removed from the analyses: Happy = 5, Sad = 5, and Control = 0 (see, Bower, Monteiro, & Gilligan, 1978, and Storbeck & Clore, 2005, for a similar procedure).[1] A 2(Induction Time) by 3(Mood) analysis of variance (ANOVA) was conducted. As expected, a significant Mood main effect, $F(2, 176) = 112.4$, $p < .001$, $\eta^2 = 0.57$, was observed. Also as expected, neither the main effect for Induction Time nor the interaction of Induction Time and Mood were significant, F's < 1. Post hoc comparisons for Mood found that the happy group was happier than the sad group, $p < .001$, and the control group, $p = .035$. The sad mood group was less happy than the control group, $p < .001$. Table 1

[1] Hypotheses concerned the effect of mood on learning, rather than the effectiveness of inducing moods. Because appropriate comparisons are between individuals for whom the mood manipulation was successful, we included only individuals whose scores were greater than 2 points below the median self-reported mood score in the happy condition and less than 2 points above the median in the sad condition.

Table 1
Mean Measures for Dependent Variables in Experiment 1a

Dependent variable	Mood groups		
	Happy	Sad	Control
Mood induced before learning			
Mean mood rating of happiness	5.28 (1.02)	2.14 (1.11)	4.81 (1.24)
Probability of hits for resented items	0.71 (0.11)	0.64 (0.16)	0.70 (0.13)
Veridical recognition			
Probability of hits for critical lures	0.79 (0.13)	0.69 (0.17)	0.78 (0.14)
Probability of FA for presented items	0.23 (0.14)	0.23 (0.14)	0.22 (0.13)
Probability of FA for critical lures	0.38 (0.21)	0.37 (0.23)	0.32 (0.19)
Sensitivity, A′, for presented items	0.84 (0.07)	0.79 (0.09)	0.81 (0.08)
Response bias, B″, for presented items	0.17 (0.28)	0.18 (0.34)	0.13 (0.28)
Mood induced after learning			
Mean mood rating of happiness	5.25 (0.93)	2.52 (1.09)	4.74 (0.98)
Probability of hits for presented items	0.63 (0.18)	0.71 (0.15)	0.67 (0.14)
Probability of hits for critical lures	0.70 (0.18)	0.73 (0.18)	0.73 (0.15)
Probability of FA for presented items	0.21 (0.14)	0.24 (0.18)	0.20 (0.13)
Probability of FA for critical lures	0.25 (0.18)	0.32 (0.20)	0.33 (0.19)
Sensitivity, A′, for presented items	0.80 (0.07)	0.83 (0.08)	0.82 (0.06)
Response bias, B″, for presented items	0.18 (0.39)	0.12 (0.35)	0.17 (0.37)

Note. The table presents the means and standard deviations (in parentheses) for relevant dependent variables. FA = false alarm.

displays the means and standard deviations for the affective ratings.

Recognition

We computed four recognition variables. "Hits" corresponded to saying *yes* to items that had been presented. "False alarms" corresponded to saying *yes* to nonpresented foils. "Critical Lure Hits" corresponded to saying *yes* to critical lures related to lists presented (if set A was presented, then a critical lure hit would consist of saying *yes* to the critical lures associated with set A). "Critical Lure False Alarms" corresponded to saying *yes* to critical lures unrelated to lists presented (e.g., saying *yes* to set B critical lures when set A lists were studied). Note that Critical Lure Hits and Critical Lure False Alarms both represent false alarms, as these items were never presented during learning.

To examine whether affect influenced any of the four recognition variables, we conducted a 2(Induction Time) by 3(Mood) multivariate ANOVA. As expected, there was a significant interaction between Induction Time and Mood, $F(8, 338) = 2.045$, $p = .041$, $\eta^2 = 0.046$. The main effect for Induction Time, $F < 1$, and Mood, $F = 1$, were nonsignificant. Because the interaction was significant, we decomposed the interaction by the timing of the mood induction. Table 1 displays the means and standard deviations for all nonsignificant recognition and signal detection effects.

Mood induced before learning. A critical prediction was that sad moods induced before learning would reduce false memories. A one-way ANOVA on false recognition of critical lures showed a significant main effect, $F(2, 82) = 3.1$, $p = .05$, $\eta^2 = 0.070$, and post hoc analyses revealed that the sad mood group recognized fewer critical lures compared to both Happy, $p = .031$, and Control, $p = .029$, groups. Happy and Control groups did not differ, $p = .87$, in their recognition of critical lures. The main effects for Hits, $F(2, 82) = 1.77$, $p = .18$, $\eta^2 = 0.042$, False Alarms, $F < 1$, and Critical Lure False Alarms, $F < 1$, were all found to be nonsignificant.

Mood induced after learning. In a similar analysis of recognition responses for critical lures when mood was induced after learning, the main effect for Mood was not significant, $F < 1$, indicating that a sad mood induction after learning did not reduce the recognition of critical lures.[2] The main effects for Hits, $F(2, 90) = 1.69$, $p = .19$, $\eta^2 = 0.036$, False Alarms, $F < 1$, and Critical Lure False Alarms, $F(2, 90) = 1.50$, $p = .23$, $\eta^2 = 0.032$, were all nonsignificant. Thus, sad moods reduced recognition of critical lures only when the mood was induced *before* learning and not after learning.

Signal Detection

Sensitivity. The sensitivity measure provides two benefits over raw recognition scores. First, it takes into account both hits and false alarms, providing a more accurate test of memory. Second, it reveals the strength of activation for items in memory. The measure of sensitivity selected was A′, which yields a score from 0 to 1, where 0 reflects poor discrimination, and 1 reflects perfect discrimination (between presented vs. nonpresented words or related vs. nonrelated critical lures). For critical lures, we made two assumptions. First, unrelated critical lures (e.g., critical lures for set B when set A was studied) should never be recognized as having been presented. Second, related critical lures that are strongly activated should be more likely to be recognized as having been presented and critical lures that are weakly activated should be less likely to be recognized. Therefore, based on these assumptions, a score closer to 1 means a person responded *yes* to related critical lures and *no* to unrelated critical lures. See Appendix A for equation of A′.

Response bias. The response bias measure indicates whether an individual displayed a response bias when making a recognition decision. A negative B″ score reflects a conservative bias (likely to respond *no*) and a positive score reflects a liberal bias (likely to respond *yes*). See Appendix A for equation of B″.

Multivariate ANOVA

To examine whether affect and the timing of the mood induction influenced sensitivity or response bias, we conducted a 2 (Induc-

[2] Power Analysis. Because we observed, as expected, a null effect for the hit recognition for related critical lures, we conducted a power analysis to determine whether we had sufficient power. We used an estimated effect size based on mood before learning condition, (effect size = 0.33), and the resulting analysis revealed that we did have sufficient power to observe an effect, Power = 0.83 (see Cohen, 1988).

tion Time) by 3 (Mood) multivariate ANOVA with A′ for presented words, A′ for critical lures, and B″ for presented words. As expected, we found a significant interaction between Induction Time and Mood, $F(6, 338) = 2.53$, $p = .021$, $\eta^2 = 0.043$. Neither main effect was significant, F's < 1. Subsequent significant interactions between Induction Time and Mood were observed for A′ for presented words, $F(2, 175) = 3.05$, $p = .05$, $\eta^2 = 0.035$, and A′ for critical lures, $F(2, 175) = 3.97$, $p = .021$, $\eta^2 = 0.045$. However, B″ for presented compared to nonpresented items was not significant, $F < 1$. Again, the interaction was decomposed into mood induced before or after learning.

Mood before learning. We predicted that affect would influence processing styles and hence the strength of activation of critical lures. To test this prediction, we conducted three one-way ANOVAs for Mood, one for each signal detection parameter. First, we assessed A′ for critical lures by Mood and as predicted, a significant effect was observed, $F(2, 82) = 3.54$, $p = .03$, $\eta^2 = 0.08$. Thus, mood influenced the sensitivity score for critical lures (A′). Post hoc analyses revealed that the Sad mood group was worse at differentiating related from unrelated critical lures than the Happy mood group, $p = .04$ or the control group, $p = .01$. However, the Happy mood and Control groups were not different in their ability to differentiate related from unrelated critical lures, $p = .73$. Mean scores of A′ for the critical lures are shown in Figure 2. By contrast, none of the other one-way ANOVAs showed significant effects: A′ for presented items, $F(2, 82) = 1.91$, $p = .16$, $\eta^2 = 0.045$, and B″ for presented items, $F < 1$.

Induced after learning. Recognition data from the condition in which mood was induced after learning can help determine whether mood states have an influence at the time of retrieval. We predicted that affect would not influence retrieval effects. Three more one-way ANOVAs showed no effects, as predicted: A′ for critical lures, $F < 1$, A′ for presented items, $F(2, 92) = 1.10$, $p = .34$, $\eta^2 = 0.024$, and B″ for presented items, $F < 1$.[3]

Sad mood and sensitivity. The most convincing evidence that negative affect did not influence retrieval effects comes from a comparison of the two Sad mood groups (mood before vs. after). An independent t test on A′ for *critical lures* showed that sad mood reduced sensitivity to critical lures when induced before, compared to after, learning, $t(50) = -2.21$, $p = .03$.

The results of the experiment were clear: negative moods induced prior to learning reduce false memory effects. The fact that false memories were reduced only when negative affect was induced prior to, but not after, learning suggests that negative affect influenced encoding processes. In addition, when the negative mood state was induced after learning it led to a similar level of false memory recognition as the Happy and Control conditions, suggesting that negative affect had no influence on the retrieval of critical lures. These results are consistent with predictions from the affect-as-information approach.

Experiment 1b

One concern of the current study was whether valence and arousal were confounded. Corson and Verrier (2007) observed that arousal, rather than valence, influenced the false memory effect. They found that arousing mood states of happiness and anger produced higher levels of false recall and recognition compared to emotional states that were low in arousal (sad, serene, or neutral). This finding contradicts the findings of Storbeck and Clore (2005) and of Experiment 1a. Prior research by Storbeck and Clore (2005) did not assess arousal and therefore cannot address the arousal question directly. The same was true in the current Experiment 1a. Therefore, we asked a second group of participants to make arousal ratings of the films. The goal was to determine how they varied in valence and arousal.

Method

Participants

Twenty-four participants completed the study and received course credit or money ($7.00).

Apparatus and Stimuli

Mood induction. The Positive, Negative, and Neutral Movies were used from Experiment 1a.

Mood manipulation check. The mood manipulation check consisted of three questions concerning arousal. A Felt Arousal question asked participants to "Please describe how you were feeling while viewing the set of movies." Ratings were made on a 6-point scale asking about the degree to which they felt "Emotionally Unaroused" versus "Emotionally Aroused." A Movie Arousal question asked, "How emotionally arousing did you find the movies to be." A 6-point scale was anchored by "Very Unarousing" and "Very Arousing." The final question measured arousal using the SAM scale (Lang, Bradley, & Cuthbert, 1999) in which cartoon images indicate various states of arousal (from no arousal to extreme arousal). Participants selected the cartoon image that best represented how they felt while watching the movie. In addition, we included the same valence question as a manipulation check that was used in Experiment 1a.

Procedure

Participants were randomly assigned to view one of the three conditions. Upon completion of the movie, participants answered the mood check questions.

Results

First, we wanted to assess whether the movies were rated differently with regard to valence. A one-way ANOVA was conducted using the same manipulation check question from Experiment 1a. As expected, the ANOVA was significant, $F(2, 23) = 52.84$, $p < .001$, $\eta^2 = 0.83$. Post hoc analysis using a Tukey's test revealed that the positive movies were rated as being happier than the negative movies, $p < .001$, and the neutral movie, $p < .001$. The negative movies were rated as less happy compared to the neutral movie, $p < .001$.

[3] Power Analysis. We observed a null effect for the ability to discriminate related from nonrelated critical lures. A post hoc power analysis was conducted to determine whether sufficient power existed to observe an effect. We used an estimated effect size based on mood before learning condition, (effect size = 0.35), and the resulting analysis revealed that we did have sufficient power, Power = 0.87.

To determine whether arousal differed among the three conditions, each arousal question was submitted in a one-way ANOVA. All ANOVAs were significant for condition: Felt Arousal, $F(2, 23) = 30.72$, $p < .001$, $\eta^2 = 0.75$; Movie Arousal, $F(2, 23) = 31.81$, $p < .001$, $\eta^2 = 0.75$; and SAM, $F(2, 23) = 19.00$, $p < .001$, $\eta^2 = 0.64$. For the post hoc analyses were conducted using a Tukey's test. For Felt Arousal, the positive movies were rated as more arousing than the neutral movie, $p < .001$, but not than the negative movies, $p = .13$, and the negative movies were seen as more arousing than the neutral movie, $p < .001$. For Movie Arousal, the negative movies were rated as more arousing than the positive movies, $p = .02$, and as more arousing than the neutral movie, $p < .001$, and the positive movies were rated as more arousing than the neutral movie, $p < .001$. For the SAM scale, the negative movies were seen as more arousing than both the positive movies, $p = .036$, and the neutral movie, $p < .001$, and the positive movies were rated as more arousing than the neutral movie, $p < .001$. In general the negative movies were seen as more arousing than the positive and neutral movies. See Table 2 for the means and standard deviations for the affective ratings of the movies.

Discussion

The findings of the movie ratings suggested that the negative mood condition produced higher levels of arousal compared to the positive movies and the neutral movie. Corson and Verrier (2007) have argued that arousal, not valence, influences the false memory effect. If so, we should have observed more false memories in the sad mood condition compared to the happy mood condition or at least similar levels of false memories. That was not the case. However, because participants in Experiment 1a did not provide arousal ratings, we cannot definitely claim that arousal did not have an influence on the false memory effect in those data.

General Discussion

We found that sad moods induced *prior to* learning reduced the number of false memories endorsed in a recognition task and also reduced the ability to discriminate related from unrelated critical lures. In contrast, sad moods induced *after* learning failed to influence false memories or the discrimination of related from unrelated critical lures. Moreover, affective cues had little influence on retrieval processes, including response biases. This was true even when moods were induced after learning, but right before the recognition test. We also note that there were no significant differences on any of the signal detection measure between the happy and control groups, regardless of whether mood was induced before or after learning. Finally, Experiment 1b revealed that arousal in responses to the negative movies was greater than arousal in response to the positive movies, indicating that arousal does not necessarily increase false memories.

The current experiment replicated and extended in several different ways the findings of Storbeck and Clore (2005). First, we found that mood states induced prior to learning influence how information is encoded, which moderated long-term memory and false memories. Second, we discovered that sad moods induced prior to encoding reduce the activation and recognition of critical lures. This fact was evident in a reduction in sensitivity (A′) when assessing critical lures. Third, retrieval effects, when separated from encoding effects, have no influence on the recognition of presented items or the discrimination of critical lures. Fourth, the influence of affect on false memory production reported by Storbeck and Clore (2005) is robust across variations in mood induction procedures and recognition tasks. The current findings are consistent with expectations from affect-as-information theory, and other affective theories suggesting that negative moods reduce spreading activation (Fiedler, 2001; Isen, 1999; Kuhl, 2000). However, the results were different than those obtained by Corson and Verrier (2007) in that increases in arousal failed to increase false memories.

Item-Specific Processing and Semantic Activation

The underlying mechanism of the false memory phenomenon is semantic activation (Roediger, Balota, & Watson, 2001). The activation of critical lures is automatic, and therefore reducing such effects requires reducing semantic activation (Roediger, Balota, et al., 2001). Studies have found that semantic activation can be reduced during encoding by drawing attention to unique features of presented items (Hege & Dodson, 2004; Dodson & Schacter, 2001). Because item-specific processing comes at the cost of relational processing (Arndt & Reder, 2003), it reduces the activation of related concepts in memory and in turn reduces false memories.

We argue that negative affect induced prior to learning reduces the activation of critical lures, because it promotes item-specific processing. Support for this interpretation comes from the fact that individuals in negative moods were no more likely to respond to related critical lures, which were strong associates of the words they had studied, than they were to respond to unrelated critical lures, which were not at all associated with the words they had studied. Further evidence that negative affect led to item-specific processing, which reduced the activation of semantically associates, was that negative affect influenced false memory effects only when it was induced prior to learning. The failure of affective influences to play any role during retrieval indicates that affect operates at encoding. These findings are consistent with those of Storbeck and Clore (2005), in particular with Experiment 2, in which we found that negative affect kept critical lures from coming to mind. Moreover, evidence that affective valence rather than affective arousal may be the critical factor comes from the fact that the negative mood induction in the current research was highly

Table 2
Mean Ratings for the Movie Clips, Experiment 1b

	Movie conditions		
Dependent variable	Positive ($N = 8$)	Negative ($N = 8$)	Neutral ($N = 8$)
Affect ratings for movies			
Mean mood rating of happiness	6.13 (0.99)	1.75 (0.71)	4.13 (0.83)
Mean rating for felt arousal	4.63 (1.19)	5.63 (0.52)	1.88 (1.13)
Mean rating for movie arousal	4.50 (0.76)	5.75 (0.46)	2.38 (1.19)
Mean rating for SAM scale	6.00 (1.77)	8.50 (0.53)	2.75 (2.66)

Note. The table presents the means and standard deviations (in parentheses) for relevant dependent variables.

arousing, but did not yield false memory effects. Therefore, in these experiments, negative affective cues, rather than low arousal cues, promoted the item-specific encoding that reduces semantic activation and false memory effects.

Similar results have been observed with other paradigms that require semantic activation, including semantic priming paradigms. Prior evidence suggests that manipulations that promote item-specific processing also reduce semantic priming effects (Stolz & Besner, 1996). Indeed, negative affect has been found to reduce both semantic and affective priming effects (Corson, 2002; Storbeck & Clore, 2008). In addition, negative affect reduces semantic coherence judgments (Bolte, Goschke, & Kuhl, 2003), which rely on semantic activation. Therefore, we argue that negative affect reduces semantic activation due to promoting an item-specific processing style.

The results of the current study and those of the research described above are in-line with predictions made by the affect-as-information approach (Clore & Storbeck, 2006; Schwarz & Clore, 2007). This approach suggests that positive affective cues promote relational processing, which activates semantic associates. In contrast, negative affective cues promote item-specific processing, which guides attention to stimulus detail rather than to semantic associates. This relational processing explanation comes from the affect-as-information hypothesis. The current findings are also consistent with expectations from some other affective accounts, including the mood and general-knowledge-structure hypothesis (Bless, 2001), the accommodation and assimilation model (Fiedler, 2001), and the broaden-and-build theory (Fredrickson, 2001). Although these theories differ in terminology, they all lead one to expect that positive affect should promote relational or gist processing, which increases semantic activation, and that negative affect promotes something like item-specific or analytic processing, which decreases widespread semantic activation.

Issues and Limitations

One issue concerns the role arousal has on the false memory effect. There were clear differences between the current findings and Corson and Verrier (2007), particularly in the negative condition. In the current experiment, Corson and Verrier would have predicted that our sad mood condition should have produced the most false memories because of its elevated arousal level. However, this was not the case. Corson and Verrier used anger as their negative, high arousing emotional state, which created a confound between valence and motivation-orientation. Anger is unique in that it is negative in valence, but it is an approach-oriented emotion like happiness (Harmon-Jones & Sigelman, 2001). It is unclear whether arousal or approach motivation influenced the formation of false memories. Given the results of the current study, we conclude that either positive affect or approach motivation might increase false memory effects rather than arousal.

Another difference between Corson and Verrier's and our own studies concerned the performance of the sad mood group relative to the control group. In their study, the sad condition was similar to the control condition in the production of false memories. However, in our studies we often find that sad moods reduce false memories compared to controls. We suggest that this could be due to the nature of the control group and to other methodological details of the DRM lists and presentation rates. Control groups in Storbeck and Clore are in their natural affective state which is usually quite positive (Diener & Diener, 1996), whereas Corson and Verrier induced a neutral mood, a procedure that commonly leads to more negative states than when resting mood is used. Therefore, details of the way that control groups are created can bring them closer to positive or to negative mood states. In addition, prior research finds that longer presentation rates for DRM items reduce false memory effects (McDermott & Watson, 2001). Our presentation rates were shorter than those used by Corson and Verrier, which should have optimized false memory production, which should have been most apparent in the control condition. Clearly more research is needed to determine the relative effects of arousal and motivational orientations, the optimal design for a control group, and the effects of other methodological details on false memories.

Conclusion

One role played by affect is to regulate cognitive processes. Explicit cognitive control can influence how information is acquired, which in turn influences false memory production. We demonstrated here that affective cues too can influence how information is learned, without requiring explicit cognitive control. The observation that mood affects cognitive processing without explicit attempts at control, is consistent with the idea that specific moods may naturally foster specific cognitive orientations. Such a link may be adaptive because it reduces the need for the effortful regulation of cognitive processes, thereby freeing up resources that would otherwise be used to engage in explicit control. This research also suggests that positive affect may promote relational qualities that aid in the use of language, a naturally social function, whereas negative affect may promote item-specific processing that aids in identifying problems within one's environment. We assume that such affective influences can enhance high-level cognitive performance when the strategy promoted by an affective state matches the demands of the task.

The false memory task promotes memory errors and illusions. These illusions are caused by relating new information to concepts already in memory. Such relational processing is often useful in learning, but it also makes one susceptible to illusions. We were able to exploit this susceptibility to better understand the role of affect in learning and memory. We found that sadness reduced such illusions by promoting an item-specific processing style, which focuses attention on concrete perceptual details rather than on abstract conceptual relations. As a result, related concepts failed to become activated and hence did not infiltrate memory.

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Appendix A

The equations used for both A′ and B″ were selected based on the recommendations of Snodgrass and Corwin (1988).

Equation for A′ (Sensitivity). A′ was defined as A′ = 0.5 + [(H – FA)(1 + H – FA)]/[(4H(1 – FA)], where H is p(Hits) and FA is p(false alarms). In addition, we transformed hits and false alarms to avoid potential division by zero, with the function: p(x) = (x + 0.5)/n +1, where x = the dependent variable and n is the number of total items for each group.

Equation for B″ (Response Bias). To calculate a response bias score, we transformed the hit and false alarm rates to avoid potential division by zero, with the function: p(x) = (x + 0.5)/n +1; where x is the dependent variable and n is the number of total items for each variable. B″ was used to calculate response bias and the equation was: B″ = [H(1 – H) – FA(1 – FA)]/[H(1 – H) + FA(1 – FA)], where H is p(Hits) and FA is p(false alarms).

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