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Negative affect promotes encoding of and memory for details at the expense of the gist: Affect, encoding, and false memories

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I investigated whether negative affective states enhance encoding of and memory for item-specific information reducing false memories. Positive, negative, and neutral moods were induced, and participants then completed a Deese–Roediger–McDermott (DRM) false-memory task. List items were presented in unique spatial locations or unique fonts to serve as measures for item-specific encoding. The negative mood conditions had more accurate memories for item-specific information, and they also had fewer false memories. The final experiment used a manipulation that drew attention to distinctive information, which aided learning for DRM words, but also promoted item-specific encoding. For the condition that promoted item-specific encoding, false memories were reduced for positive and neutral mood conditions to a rate similar to that of the negative mood condition. These experiments demonstrated that negative affective cues promote item-specific processing reducing false memories. People in positive and negative moods encode events differently creating different memories for the same event.

Keywords: Affect; False memories; Learning.

Everyday cognition requires a constant interplay of perception and cognition, which involves both taking in new information from the senses and bringing to bear interpretations from memory (Neisser, 1976). Two processing—or encoding—styles, item-specific and relational, capture the extreme ends of this interplay of perception and cognition (Anderson, 1976; Brainerd & Reyna, 1998; Einstein & Hunt, 1980; Hunt & McDaniel, 1993). Item-specific processing involves encoding perceptual features, details, and distinctive qualities of incoming information, whereas relational encoding involves conceptually processing incoming stimuli in relation to each other and to previously stored concepts in memory. In the current studies, I examined whether affective states modulate learning styles by presenting information that allowed for both detail- and conceptual-oriented encoding within the context of a false-memory paradigm.

False-memory paradigm

The Deese–Roediger–McDermott (DRM) false-memory paradigm reliably produces false memories

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by presenting a list of words that are closely related to a single, non-presented word, referred to as the critical lure (Roediger & McDermott, 1995). For instance, the words bed, pillow, wake, rest, and dream are presented, but the related critical lure, *sleep*, is not. Often, though, *sleep* is recollected, which is considered a false memory.

Roediger, Watson, McDermott, and Gallo (2001) developed the activation/monitoring framework, which provides one explanation for false-memory production. Their framework contends that two processes—semantic activation and monitoring—largely account for the false recollection of critical lures. Semantic activation of the critical lure occurs automatically and without conscious elaboration when processing a list of related words. Once the critical lure becomes active in one's mind, it is likely to be recollected as having been presented (Hancock, Hicks, Marsh, & Ritschel, 2003; Marsh, McDermott, & Roediger, 2004; McDermott & Watson, 2001; Roediger, Balota, & Watson, 2001; Roediger, Watson et al., 2001). Monitoring strategies can reduce the occurrence of false memories. Monitoring involves explicit decisions or strategies to determine whether the critical lure in mind was presented or not; however, these strategies typically reduce, but do not eliminate false memories (Dodson & Schacter, 2002; McDermott & Roediger, 1998).

An alternate account for the production of false memories comes from the fuzzy-trace theory. The main tenet of the fuzzy-trace theory is that false memories result from the way in which DRM lists are encoded (Brainerd, Wright, Reyna, & Payne, 2002). Encoding may consist of verbatim or of gist processing. Verbatim processing enhances episodic memory traces for perceptual detail or surface features, which is conceptually similar to item-specific processing. Gist processing, on the other hand, enhances episodic memory traces for the gist or theme of incoming information, which is conceptually similar to relational processing. Verbatim and gist processing operate independent of one another, and within the context of the false-memory paradigm, false memories are a result of gist processing.

If relational processing increases the likelihood of false-memory production, can preventing relational processing reduce false memories? Arndt and Reder (2003) suggested that one way to reduce relational processing is to promote attention to item-specific information. They found that presenting DRM list items in unique fonts compared to presenting DRM lists in the same font styles reduced false memories (Arndt & Reder, 2003). Hege and Dodson (2004) performed a similar experiment, but also examined whether the reduction of false memories was due to reduced activation of critical lures during learning, or changes in retrieval strategies. As expected, presenting DRM list items in unique fonts reduced the activation of critical lures, thereby reducing false memories. In another study, distinctive information pertinent to learning DRM list words was presented, promoting item-specific encoding. The distinctive information consisted of images representing the presented DRM list words (e.g., the word "NURSE" was shown with a picture of a nurse). It was found that lists in which words were presented alone had higher false-memory rates compared to lists in which words were presented with their corresponding images (Dodson & Schacter, 2001; Israel & Schacter, 1997). As such, manipulations that draw attention to item-specific information can reduce false memories.

Affect and learning styles

One role of emotion is to prioritise cognitive processes (Gray, 2001; Lang, 1995; Lazarus, 1991; Simon, 1967). Specifically, the affect-as-information hypothesis suggests that affective reactions in task situations serve as information about anticipated outcomes, which then influence how one approaches the task (Clore, Gasper, & Garvin, 2001). Task-relevant affective cues serve to promote a cognitive processing style (e.g., Clore, Wyer et al., 2001; Storbeck & Clore, 2005). Positive affect provides feelings of efficacy, thereby promoting the dominant processing style of relational processing (Clore & Huntsinger, 2007; Clore & Palmer, 2009; Clore, Wyer et al., 2001). In contrast, negative affect provides feelings of inefficacy, thereby promoting the non-dominant processing style of item-specific processing (Clore & Huntsinger, 2007; Clore, Wyer et al., 2001). Moreover, item-specific processing comes at the cost of relational processing (Arndt & Reder, 2003). Therefore, if negative affect promotes item-specific processing, it should reduce phenomena that rely on relational processing.

The DRM paradigm, as mentioned above, is a task that can examine whether affect modulates both encoding processes and memory. Storbeck and Clore (2005) found that negative affect reduces false memories within a typical DRM task. In Experiment 2, they verified that critical lure recall was reduced because fewer critical lures came to mind during encoding (as opposed to negative affective states changing retrieval strategies). In a more recent study, Storbeck and Clore (2011) manipulated the timing of the mood induction. They induced a positive, negative, or neutral mood state either before or after learning DRM lists. False recognition of non-presented critical lures was reduced only for the condition in which negative affect was induced prior to learning. Affect, though, had little influence on retrieval strategies. The weakness of the studies just mentioned is the lack of direct evidence for item-specific processing. One goal of the current research was to introduce dependent variables associated with item-specific processing. If negative mood states promote item-specific processing then there should be better memory for item-specific information and reduced false memories.

Overview and predictions

The primary goal of this research was to examine whether people in negative affective states compared to people in positive affective states have fewer false memories and better memory for item-specific details. The evidence reviewed above suggests that positive affect promotes relational processing as evidenced by higher instances of false memories, but the only evidence that negative affect promotes item-specific processes is lower instances of false memories. However, if negative affect does promote item-specific encoding, then it should benefit memory for such information. In addition, attention directed at item-specific information may disrupt relational processing, which suggests that people in the negative mood conditions should have fewer false memories. Arndt and Reder (2003) and Hege and Dodson (2004) drew attention to details of words by manipulating font style. I adopted their approach in order to assess whether information was encoded at a relational level (i.e., false memories) or at an item-specific level (i.e., recollection of detailed information). For Experiments 1 and 2, there were two dependent variables; one dependent variable associated with relational information (i.e., false memories), and the other associated with item-specific information (e.g., font style). In Experiment 3, the presence of distinctive information, in the form of pictures, was manipulated within-subjects to examine whether false memories could be reduced in positive affective states when attention was directed to item-specific features.

For the first two experiments, I predicted that people in negative moods, compared to the people in positive and neutral moods, would have better memory for item-specific information (e.g., spatial location and font styles) and fewer false memories. In Experiment 3, I predicted that people in positive moods would have fewer false memories when item-specific information was presented in conjunction with DRM list words compared to when the same individuals view DMR list items without item-specific information. Because people in negative moods already encode item-specific information, I predicted that there should be no differences in false memory recollection between the two list style conditions.

EXPERIMENT 1

The goal of Experiment 1 was to have two dependent variables: one that would assess relational processing and another that would assess item-specific processing. To achieve this goal, I modified the DRM task. DRM list items were shown in unique spatial locations, because memory for spatial location requires item-specific encoding (Brainerd & Reyna, 2002; Dodson & Schachter, 2002; Hege & Dodson, 2004; Johnson, Hashtroudi, & Lindsay, 1993). The number of false memories recalled served as the variable that assessed relational processing. I predicted that the people in the negative mood condition would recognise fewer critical lures, but correctly recognise more spatial locations for presented items compared to people in the positive mood and control conditions.

Method

Participants

Seventy-seven (59 female) Queens College – CUNY undergraduates participated to fulfil a course requirement ($M_{age} = 18.29$ years, $SD = 1.19$). All participants consented to participating in the experiment.

Materials

Mood induction. Music was used to induce a positive or negative affective state. The positive affect group listened to *Eine Kliene Nacht Musik* by Mozart for six minutes, whereas the negative affect group listened to *Adagietto* by Mahler for six minutes (Niedenthal & Setterlund, 1994; Storbeck & Clore, 2005). The control group performed the task in their daily affective state.

DRM task. Fourteen DRM lists were used, with 15 words in each list (lists were selected from Roediger & McDermott, 1995). Within each list, words were always presented in the same serial order, such that the first word was the one that was most associated with the critical lure, followed by the next most associated word, and so on (Roediger & McDermott, 1995). The screen was split in the middle both horizontally and vertically, creating four quadrants. Words were always presented in the middle of one of the four quadrants.

Mood manipulation check. The mood manipulation check consisted of a single question. It asked how participants felt while listening to the selection of music and participants responded on a 7-point scale with the anchors of "*Very unhappy*" (1) and "*Very happy*" (7).

Procedure

Instructions were provided, and participants were told a cover story to disguise the purpose of the mood induction. They were told that the selection of music was related to another experiment, and that they would be asked questions concerning their reactions to the selection of music. Participants then listened to the music and completed the false-memory task. One DRM list was presented at a time, with each word being shown for one second. Words were presented randomly in one of the four quadrants. After the last list item was presented, participants were asked to freely recall the presented items. Participants had 45 seconds for the recall task, for which they typed all of the words they could remember from the list. After the recall test, the spatial recall test was administered. Six randomly selected words from those presented were displayed one by one, and each word was shown in the middle of the screen. Participants had to recall where that word was located during the learning phase and pressed the "1", "2", "3", and "4" key for their response, which corresponded to top left, top right, bottom right, and bottom left, respectively. The number corresponding to the response key was presented in the quadrant. Because the spatial location test used items that were presented, this test was always conducted second to avoid memory contamination for the word recall test. After completing the spatial recall task, the next list was presented and the same procedure was followed for the next six lists. After the seventh list, the same mood induction was reintroduced and the remaining lists were presented. The re-induction of the mood state was done due to the length of the task and to obviate the concern of the mood *wearing off*. Participants then completed the mood check and demographic questions.

Results

Mood manipulation check

The manipulation check was submitted to a one-way analysis of variance (ANOVA), with feelings of happiness serving as the dependent variable. A significant effect of Mood was observed, $F(2, 74) = 4.27$, $p = .018$, $\eta^2 = .10$. Tukey post hoc analyses were run, and the positive condition was happier than the negative condition, $p = .015$; however, no other effect emerged, all ps $> .12$. Thus, the manipulation was successful at separating the positive and negative affective ratings; however, the control condition was not different from either the positive or negative conditions. See Table 1 for descriptive statistics.

Recall

False and spatial recall. The two variables of interest were the recall of critical lures and the recall of spatial locations of presented words. To test the prediction that the negative mood condition would recall fewer critical lures, but be more accurate at recalling spatial locations, two one-way ANOVAs were conducted with Mood (positive, negative, control) as the independent variable.[1] As expected, a Mood main effect was observed for the recall of critical lures, $F(2, 74) = 3.38$, $p = .039$, $\eta^2 = .084$. A contrast analysis was performed to examine the prediction that the negative affective condition recalled fewer false memories than the average mean of false memories for the positive and control conditions using the weights, 0.5, -1, and 0.5, for positive, negative, and control, respectively. As predicted, the contrast was significant, $t(74) = 2.42$, $p = .018$.

As for the recall of spatial location for presented words, the effect for Mood was significant, $F(2, 74) = 3.18$, $p = .047$, $\eta^2 = .079$. The same contrast analysis that was used to assess false memories, except that the $+/-$ signs were reversed, was run for spatial recall, and the effect was significant, $t(74) = -2.52$, $p = .014$. People in the negative mood condition correctly recalled more spatial locations than people in the positive and control conditions. See Figure 1 for the mean probability of recalling critical lures and spatial locations.

Table 1. *Statistics for the mood manipulation check*

	Descriptive statistics	
Mood conditions	*Happiness ratings*	*Arousal ratings*
Experiment 1		
Positive (N = 24)	5.65 (0.98)	
Negative (N = 25)	4.76 (1.39)	
Control (N = 26)	5.38 (0.94)	
Experiment 2		
Positive (N = 31)	5.60 (1.45)	4.03 (1.10)
Negative (N = 30)	1.70 (1.02)	3.63 (1.73)
Neutral (N = 25)	4.24 (1.45)	3.32 (1.41)
Experiment 3		
Positive group (N = 20)	4.65 (1.35)	3.55 (1.15)
Negative group (N = 21)	2.86 (1.53)	3.62 (1.75)
Neutral group (N = 29)	4.79 (0.98)	3.72 (1.07)

Note: Standard deviations are in parentheses.

Veridical recall and error production. To examine whether mood influenced the recall of presented items and errors, two, one-way ANOVAs were performed with Mood as the independent variable. The three conditions recalled a similar number of presented items, $F < 1$, and produced a similar number of errors, $F(2, 74) = 1.75$, $p = .18$, $\eta^2 = .045$. See Table 2 for the means and standard deviations.

Discussion

Experiment 1 revealed that participants in the negative mood condition correctly recalled more spatial locations than participants in the positive mood and control conditions. However, the negative mood condition recalled fewer non-presented critical lures than the positive mood and control

[1] An analysis was conducted to determine whether the effects differed as a result of the first or second mood induction. I compared the recall effects for presented items, critical lures, spatial locations, and errors in separate repeated-measures ANOVAs with the first and second mood induction as the repeated variable and mood as a between-subjects factor. No overall significant differences emerged, all Fs < 1.

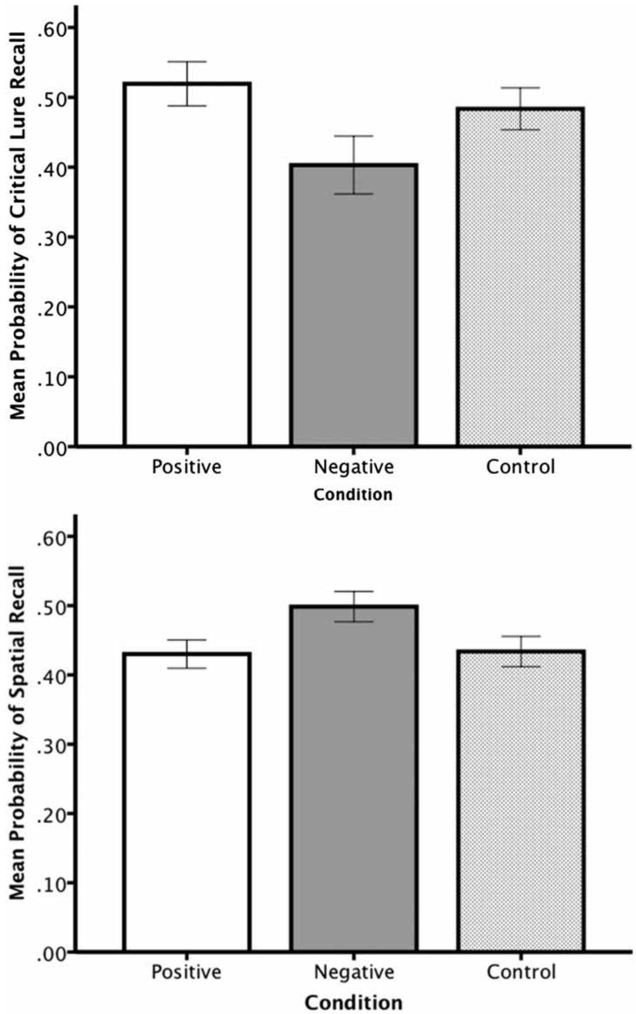

Figure 1. *Mean probability correct for the recall of critical lures (top panel) and for the recall of spatial locations for presented items (bottom panel) for Experiment 1. The bars represent 1 standard error of the mean.*

conditions. All groups recalled the same number of presented items, suggesting that these processing strategies do not interfere with the ability to remember presented words. Moreover, the lack of differences with the recall of presented items suggests that all groups put similar effort into the task.

EXPERIMENT 2

Prior research by Gray and colleagues (Gray, 2001; Gray, Braver, & Raichle, 2002) found that negative affect can enhance spatial working memory. These findings raise the possibility that the results of Experiment 1 could be due to affect interacting with working memory rather than encoding processes. Therefore, it was necessary to replicate the findings with an alternative item-specific processing task. In this experiment, I presented the words in different font styles within a given DRM list. Prior research has found that by varying the font styles for DRM list words, item-specific encoding is promoted (Arndt &

Table 2. *Means and standard deviations for dependent variables in Experiments 1, 2, and 3*

	Mood groups		
Dependent variable	*Positive*	*Negative*	*Neutral*
Experiment 1			
Total number of pres. words recalled	113.9 (15.1)	108.3 (18.0)	110.5 (13.1)
Total number of recall errors	14.00 (10.04)	10.32 (4.10)	13.31 (6.70)
Experiment 2			
Prob. of hits for related CL	0.73 (0.16)	0.60 (0.17)	0.68 (0.19)
Prob. of FA for unrelated CL	0.06 (0.09)	0.05 (0.10)	0.03 (0.06)
Prob. of hits for font styles	0.74 (0.15)	0.78 (0.15)	0.76 (0.15)
Prob. of FA for font styles	0.39 (0.21)	0.33 (0.21)	0.37 (0.13)
Prob. of hits for pres. words	0.73 (0.11)	0.73 (0.15)	0.74 (0.13)
Prob. of FA for pres. words	0.11 (0.13)	0.08 (0.11)	0.06 (0.07)
Sen., *A′*, for pres. words	0.86 (0.06)	0.84 (0.14)	0.86 (0.09)
Experiment 3			
Prob. of hits for related CL (word alone)	0.60 (0.19)	0.44 (0.19)	0.59 (0.22)
Prob. of hits for related CL (word & pics)	0.48 (0.23)	0.43 (0.24)	0.46 (0.23)
Prob. of FA for unrelated CL (word alone)	0.14 (0.09)	0.12 (0.07)	0.11 (0.12)
Prob. of FA for unrelated CL (word & pics)	0.13 (0.08)	0.12 (0.09)	0.14 (0.11)
Prob. of hits for pres. words (word alone)	0.80 (0.13)	0.85 (0.09)	0.81 (0.13)
Prob. of hits for pres. words (word & pics)	0.82 (0.11)	0.78 (0.11)	0.75 (0.11)
Prob. of FA for pres. words (word alone)	0.09 (0.10)	0.08 (0.07)	0.11 (0.11)
Prob. of FA for pres. words (word & pics)	0.09 (0.08)	0.07 (0.09)	0.11 (0.10)
Sen., *A′*, for pres. words (word alone)	0.91 (0.07)	0.93 (0.03)	0.90 (0.064)
Sen., *A′*, for pres. words (word & pics)	0.92 (0.06)	0.91 (0.05)	0.89 (0.061)

Notes: The table presents the means and standard deviations (in parentheses) for relevant dependent variables. Hits for related CL represent "yes" responses to non-pres. CL, and FAs refer to "yes" responses to unrelated, non-pres. CL. CL = critical lures; FA = false alarm; pics = pictures; pres. = presented; prob. = probability; sen. = sensitivity.

Reder, 2003; Hege & Dodson, 2004). I predicted that the negative mood condition would recall fewer false memories, but would correctly recognise more font styles compared to positive and neutral mood conditions.

Another open question was whether arousal, rather than valence, influenced false-memory recollection. Prior research has observed that high arousal, regardless of affective state, promotes false memories (Corson & Verrier, 2007). The previous experiment and our prior research (Storbeck & Clore, 2005) never assessed participants' arousal states. Therefore, a confound may have existed between valence and arousal such that the positive mood induction was both positive and highly arousing (i.e., music had a faster tempo), and the negative mood induction was both negative and low arousing. To resolve whether valence alone can account for the false-memory effect, the mood-induction procedure was equated on arousal (only for positive and negative mood conditions).

Method

Participants

Eighty-six (48 females, 1 unidentified) Queens College – CUNY undergraduates participated to fulfil a course requirement ($M_{\text{age}} = 21.35$ years, $SD = 5.45$). All participants consented to participate in the experiment.

Materials

Mood induction. Affective states were induced using a set of 30 positive, 30 negative, or 30 neutral pictures. The pictures were selected based on the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert,

1999) standardised ratings ranging on a scale from 1 (*Negative or low arousal*) to 9 (*Positive or high arousal*). The positive pictures had a mean valence rating of ($M = 7.38$; $SD = 0.69$) and a mean arousal rating of ($M = 4.70$; $SD = 0.59$), the negative condition had a mean valence rating of ($M = 3.18$; $SD = 0.92$) and a mean arousal rating of ($M = 4.70$; $SD = 0.58$), and the neutral pictures had a mean valence rating of ($M = 5.61$; $SD = 1.17$) and a mean arousal rating of ($M = 3.27$; $SD = 0.93$). A one-way ANOVA was run to ensure that the picture sets varied in valence but not arousal. A significant effect was observed for valence, $F(2, 87) = 149.07$, $p < .001$, $\eta^2 = .77$, such that the positive set was rated as being more positive than the control and negative pictures, and the control pictures were more positive than the negative pictures, all ps $< .001$. The picture sets also varied in arousal, $F(2, 87) = 39.66$, $p < .001$, $\eta^2 = .48$. Post hoc analyses confirmed that the positive and negative, $p = .99$, pictures sets did not vary, but that the neutral pictures were less arousing than both the positive, $p < .001$, and negative, $p < .001$, pictures.

False recognition paradigm. Ten lists of ten words each were used. Words were always presented in the same serial order, such that the first word was the one that was most associated with the critical lure, followed by the next most associated word, and so on. In addition, the words were presented in one of six font styles (Arial, Alba Matter, Castellar, Stencil, Bauhaus, & Gloogun). Some font styles were repeated within a list. Words were always presented in the middle of the screen, in the same font size (24 pt) and colour (black).

Recognition test. The recognition test consisted of a yes/no word recognition and yes/no font style recognition. In addition, a recognition (instead of recall) test was used for testing font styles so that participants would not have to recode the font styles into verbal labels (e.g., the word "chair" was presented in Gloogun font). For the word recognition, six words were randomly sampled from the complete 15-item DRM list (only ten words were presented at learning) and presented on the recognition test. In addition, related and unrelated critical lures for presented lists were always incorporated in the recognition test as being the fourth or fifth (randomly assigned) word presented. The unrelated critical lures were critical lures from other DRM word lists that were not presented in the current experiment, and the same unrelated critical lure was associated with the same presented DRM list (e.g., the unrelated critical lure "smoke" was always presented with the DRM list "sleep" for the recognition test). For the font style recognition test, six words were selected that were presented during the learning phase, and font styles were pseudo-randomly determined for the recognition test. That is, I ensured that at least two font styles matched between learning and recognition phases. Participants had to judge whether the word in the current font style matched the font style that word was presented in during learning.

Mood manipulation check. The mood check consisted of two questions. The first question asked participants to rate on a 7-point scale how happy the pictures made them feel, with the anchors being 1 (*Very unhappy*) to 7 (*Very happy*). The second question asked participants to rate on a 7-point scale how aroused they felt after viewing the pictures, with the anchors being 1 (*Very calm*) to 7 (*Very aroused*).

Procedure

Instructions were provided and participants were told a cover story to disguise the purpose of the mood induction. Participants viewed the positive, negative, or neutral picture set, and each picture was shown for five seconds. Then all participants completed the false-memory task. Instructions were provided, and the first list was presented. Each word was shown for 500 ms. After the last word from the particular DRM list was presented, the word recognition test was administered followed by the font style recognition test. The font style recognition test always followed the word recognition test to avoid memory contamination. The next list was then presented followed by the recognition tests. This continued until all ten lists had been shown in a randomised order. Participants then completed the mood check and demographic questions.

Results

Mood manipulation check

Valence. One person failed to self-report their affective state; however, their data was included in the recognition analysis. The main effect of valence was observed, $F(2, 82) = 67.62, p < .001, \eta^2 = .62$. Tukey post hoc analysis confirmed that each condition was significantly different from each other condition, all ps $< .01$. The positive condition reported the highest level of happiness, and the negative condition reported the lowest level of happiness. See Table 1 for descriptive statistics for both valence and arousal.

Arousal. The main effect of arousal failed to reach a level of significance, $F(2, 82) = 1.71$, $p = .19$, $\eta^2 = .04$. Therefore, participants did not vary with respect to their self-reported feelings of arousal.

Critical lure and font recognition

Critical lure. Typical nomenclature within the false memory literature identifies a "yes" response to a critical lure as a "hit". In being consistent with the literature, I will refer to participants saying "yes" to a related, *non-presented* critical lure as a hit and saying "yes" to an unrelated, *non-presented* critical lure as a false alarm. I predicted that people in the negative mood condition would recognise fewer critical lures (i.e., have fewer hits for related critical lures) compared to people in the positive and neutral mood conditions. To test this prediction, a one-way ANOVA was run to assess the impact of Mood (positive, negative, neutral) on the probability of recognising critical lures. As expected, the main effect for Mood was significant, $F(2, 83) = 4.80$, $p = .011$, $\eta^2 = .11$. A contrast analysis was run using the same weights as in Experiment 1, and the effect was significant, $t(83) = 2.84, p = .006$, in support of the prediction. I also assessed whether there were differences for unrelated critical lures (false alarms), and no effect was observed, $F(2, 83) = 1.07$, $p = .35$, $\eta^2 = .02$ (see Table 2 for means).

Sensitivity (A') was used to measure how well participants discriminated between related critical lures and unrelated critical lures on the recognition test (see Appendix 1 for equations, and Roediger & McDermott, 1999; Wixted & Stretch, 2000, on using sensitivity with false memories). A one-way ANOVA was run to assess the influence of Mood on sensitivity, A'. As predicted, a significant effect of Mood was observed, $F(2, 83) = 7.17$, $p = .001$, $\eta^2 = .15$. A contrast analysis was run to test the prediction that participants in a negative mood state would have the lowest sensitivity for recognising critical lures, and the same weights were used as in Experiment 1. The contrast was significant, $t(83) = 3.74$, $p < .001$, in support of the prediction. See Figure 2 for a graphical representation of the means for critical lure sensitivity.

Font styles. Hits and false alarms were calculated for the recognition of font styles. Hits consisted of saying "yes" to words in which the font style was the same for both the learning and recognition phases. False alarms consisted of saying "yes" to words in which the font style was different between the learning and recognition phases. I predicted that the negative mood condition would have more hits (i.e., better recognition) for font styles of presented words compared to the positive and neutral conditions. A one-way ANOVA was run to test this prediction. Contrary to the prediction, there were no differences among the mood conditions for font style hit rates, $F < 1$. I then assessed the false alarms for font style, and no significant effect emerged, $F < 1$. See Table 2 for relevant means and standard deviations.

I then assessed whether the negative mood group was more sensitive, A', for correctly recognising font style presentation of presented words compared to the positive and neutral conditions. The effect of Mood was significant, $F(2, 83) = 14.55$, $p < .001$, $\eta^2 = .26$. The contrast analysis was also significant, $t(83) = -4.96$, $p < .001$, in that the negative mood condition had a higher

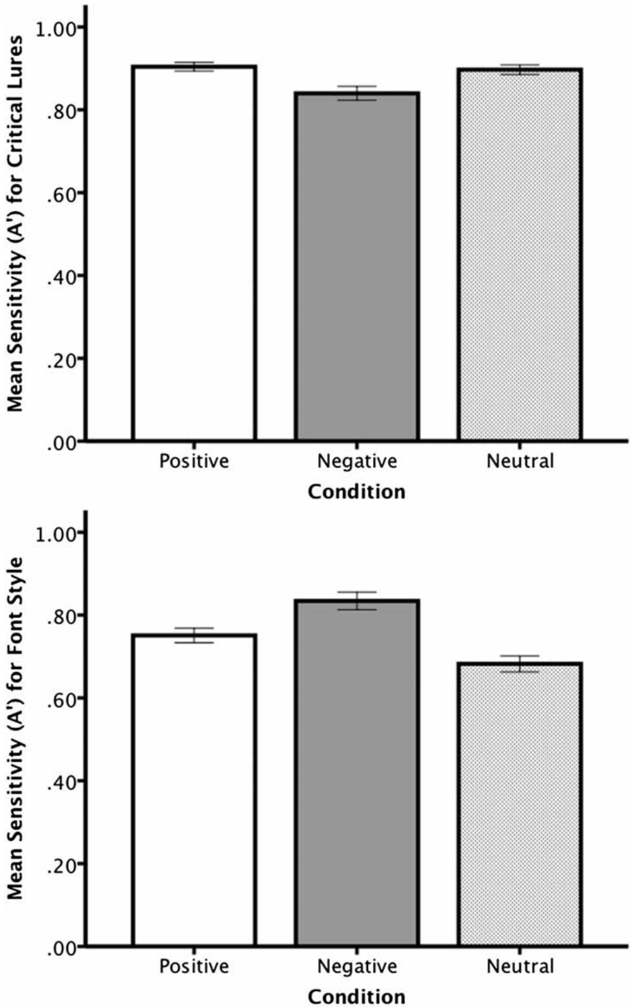

Figure 2. *Mean probability correct for the recognition of critical lures (top panel) and the font styles of presented items (bottom panel) for Experiment 2. The bars represent 1 standard error of the mean.*

sensitivity score compared to the other two conditions. See Figure 2 for a graphical representation of the means for font style sensitivity.

Veridical recognition and error production. To examine whether mood influenced the recognition of presented items, a one-way ANOVA was conducted, and it failed to reach significance, $F < 1$. As for non-presented words, another non-significant effect was observed, $F(2, 83) = 1.32$, $p = .27$, $\eta^2 = .03$. Another analysis to determine if affect influenced the sensitivity, A', of recognising presented items was run, and a non-significant effect was observed, $F < 1$. See Table 2 for means and standard deviations.

Discussion

The current experiment was important for two reasons. First, it was demonstrated that people in negative moods encoded item-specific information in a non-spatial domain to a greater degree than people in positive and neutral mood states. Moreover, this finding suggests that the results of the first experiment were not due to negative affect solely influencing spatial working memory (see Gray, 2001, for affective influences on working memory). Second, the level of arousal was controlled for and valence was varied between the conditions. Therefore, the effects were driven by valence, suggesting that valence alone is sufficient to induce different processing styles that influence memory. However, I do note that this study cannot determine whether arousal alone can modulate the false-memory effect, because arousal was not directly manipulated.

EXPERIMENT 3

For Experiment 3, attention was manipulated to perceptual details in order to examine whether false memories can be reduced for people in positive and neutral mood states. The typical false-memory task promotes attention to semantic qualities, which results in false memories (Roediger, Balota et al., 2001; Roediger & McDermott, 1995). However, attention can be directed away from semantic qualities to perceptual qualities by the inclusion of pictures. As mentioned above, Israel and Schacter (1997) presented both a word and a line drawing representing DRM list words. For example, a trial would consist of seeing the word "NURSE" along with a picture of a nurse. They found a reduced false-memory effect (compared to conditions where only words were presented). Therefore, the line drawings served as perceptual cues designed to aid in learning the presented words; however, attending to the line drawings should disrupt gist processing. This manipulation is in contrast to the manipulations in the first two experiments, because perceptual information competed with the learning of semantic information.

In the current experiment, I adopted the experimental manipulation from Israel and Schacter (1997). Half of the DRM lists were presented with words alone and the other half of the lists were presented with words and pictures, creating a within-participants manipulation. I predicted that the participants in the positive and neutral mood conditions would recognise more critical lures for the word alone condition compared to the word and picture condition. For the negative mood condition, I predicted that there would be no differences in false-memory production between the word alone and the word and picture conditions, because the encoding strategy (i.e., item-specific encoding) should be similar for both list types. Moreover, I also predicted that for the word alone condition, participants in the negative mood condition would recognise fewer critical lures compared to the participants in the positive and neutral mood conditions. However, I predicted that participants for all conditions would have similar levels of critical lure recognition in the word and picture condition.

Method

Participants

Seventy (49 females) Queens College – CUNY undergraduates participated to fulfil a course requirement ($M_{age} = 22.04$ years, $SD = 5.20$). All participants consented to participating in the experiment.

Materials

Mood induction. The mood induction was the same as in Experiment 2.

False recall paradigm. Fourteen DRM lists were selected, and each list had 14 words. Each list was constructed such that the first word was the most associated word to its related critical lure, and the last was the least associated. The lists were divided into two sets (A and B) each consisting of seven lists. Half of the participants saw set A lists with only words and set B lists with words and pictures, whereas the other half of the participants saw set A lists with words and pictures and set B lists with only words. The first nine words were presented during learning and for one set (either A or B depending on random assignment), each word had an accompanying picture. The remaining five words were used for foils (distractor items) on the recognition test. The pictures consisted of drawings representing the words (Israel & Schacter, 1997).

Recognition test. The recognition test consisted of seven words. Five words consisted of presented or non-presented words, one word was the related critical lure, and one word was the unrelated critical lure. The related and unrelated critical lures were presented as the fourth and fifth items in the test, and the order was randomised as to which word was presented in the fourth position versus the fifth position. The presented or non-presented items were randomly selected from the total list of 14 items, nine of which were presented during learning.

Mood manipulation check. The mood manipulation check was the same check as presented in Experiment 2.

Procedure

The procedure was the same as in Experiment 2, with the exception of the DRM task. After the completion of the mood induction, participants were provided instructions about the false-memory task. The instructions informed participants that some lists would consist of only words and some of both words and pictures. They were told to remember the words and that the pictures would serve to aid learning. Lists from sets A and B were randomly presented, such that word alone lists and word and picture lists were intermixed. Stimuli for each trial were shown for 500 ms. After the last item of the list was presented, the recognition test for that list was given. Words were presented one at a time and participants were asked whether or not the item was presented by pressing the A (yes) or the L (no) key. After the recognition test for the list, the next list was presented followed by its recognition test. This was repeated until all lists had been presented and all recognition tests given. Participants then completed the mood check and demographic questions.

Results

Mood manipulation check

Valence. The main effect of valence was observed, $F(2, 67) = 16.17$, $p < .001$, $\eta^2 = .33$. Tukey post hoc analysis confirmed that the negative condition was less happy than the positive and neutral conditions, all ps $< .01$; however, the positive and neutral conditions had similar affective ratings, $p = .92$. See Table 1 for descriptive statistics for both valence and arousal.

Arousal. The main effect of arousal failed to reach a level of significance, $F < 1$. Therefore, participants did not vary with respect to their self-reported feelings of arousal.

Recognition

Critical lure. A one-way ANOVA was run to assess whether Mood influenced critical lure recognition. For the word alone conditions, mood influenced the probability of recognising critical lures, $F(2, 67) = 4.67$, $p = .013$, $\eta^2 = .12$. A contrast analysis was performed to test the prediction that people in the negative mood condition would recognise the fewest critical lures. As expected, the contrast analysis was significant, $t(67) = 3.05$, $p = .003$. For the word and picture condition, mood did not influence the ability to recognise critical lures, $F < 1$, as predicted. False alarm rates were assessed with a one-way ANOVA, and no significant effects emerged for words alone, $F < 1$, and word and picture, $F < 1$, conditions. Sensitivity was assessed, and for within the word alone conditions a significant effect was observed, $F(2, 67) = 3.32$, $p = .042$, $\eta^2 = .09$. As predicted, participants in the negative condition had the lowest critical lure sensitivity score, $t(67) = 2.55$, $p = .013$. For the word and picture condition, as predicted, mood failed to influence the sensitivity for recognising critical lures, $F < 1$ (see Figure 3 for mean sensitivity for recognition of critical lures). See Table 2 for condition means that are not displayed graphically.

Next, I examined whether critical lure recognition differed depending on the DRM presentation manipulation (i.e., word alone vs. word & picture) within each Mood condition. For the positive mood condition, there was a higher sensitivity score for the word alone condition compared to the word and picture condition, $t(19) = 2.33$,

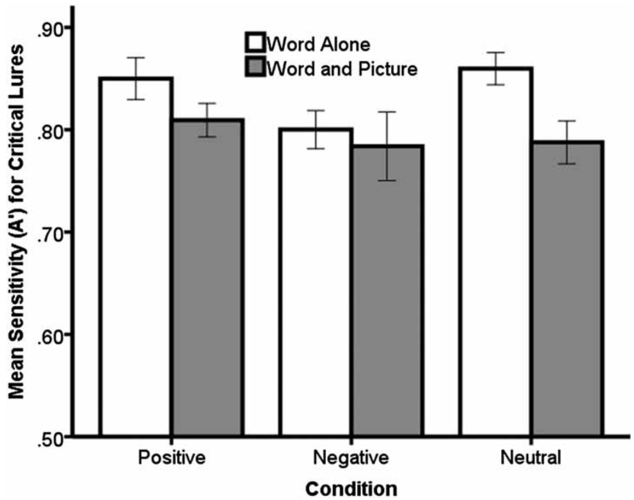

Figure 3. *Mean sensitivity (A′) score for critical lures by presentation style for Experiment 3. The bars represent 1 standard error of the mean.*

$p = .033$. For the negative mood condition, there were no differences in sensitivity, $t(20) = 0.47$, $p = .65$, as predicted. For the neutral mood condition, there was a higher sensitivity score for the word alone condition compared to the word and picture condition, $t(28) = 2.87$, $p = .008$. Therefore, participants in the positive and neutral conditions had higher sensitivity scores for recognising critical lures for word alone conditions than word and picture conditions.

Presented and non-presented item recognition. Analyses were run to examine whether Mood influence the probability to recognise presented items and non-presented items. For word alone lists, Mood did not influence either recognition for presented words, $F(2, 67) = 1.11$, $p = .34$, $\eta^2 = .032$, or recognition of non-presented words, $F < 1$. Sensitivity was also assessed for presented and non-presented items, and no significant effect emerged, $F(2, 67) = 1.61$, $p = .21$, $\eta^2 = .046$. For the word and picture condition, Mood also did not influence either recognition of presented items, $F(2, 67) = 2.02$, $p = .14$, $\eta^2 = .057$, or recognition of non-presented items, $F(2, 67) = 1.22$, $p = .30$, $\eta^2 = .035$. Again, sensitivity was assessed, and no significant difference emerged, $F(2, 67) = 2.30$, $p = .10$, $\eta^2 = .066$, although there was a trend for an effect.

Next, I examined within each affective condition whether the recognition of presented and non-presented items were recognised differently based on presentation style (i.e., word alone vs. word & picture). For the positive condition, no differences emerged for the probability of recognising presented items, $t(19) = -0.52$, $p = .61$, or non-presented items, $t(19) = -0.53$, $p = .60$, or for sensitivity, $t(19) = -0.78$, $p = .45$. For the negative condition, a difference in recognition of presented items, $t(20) = 2.46$, $p = .023$, was observed such that more presented items were recognised in the word alone condition compared to word and picture condition. No differences were observed for recognition of non-presented items, $t(20) = -0.72$, $p = .47$, or sensitivity, $t(20) = 1.75$, $p = .10$. For the neutral condition, a difference in recognition of presented items, $t(28) = 2.04$, $p = .051$, was observed such that more presented items were recognised in word alone condition compared to word and picture condition. No differences were observed for the recognition of non-presented items, $t(28) = -0.16$, $p = .88$, or for sensitivity, $t(28) = 1.67$, $p = .11$. Thus, for the negative and neutral conditions, participants had different hit rates between word alone and word and picture conditions; however, when false alarms were taken into account with the sensitivity score, the effects became non-significant.

Discussion

I found that the recognition of critical lures was influenced by both the affective state and the presentation style of list items. The important finding was that more critical lures were recognised by participants in the positive and neutral conditions when attention was focused to semantic information only (i.e., word alone condition); however, fewer critical lures were recognised when attention was focused to perceptual information (i.e., word and picture condition). As for the negative condition, there were no differences in the recognition of critical lures regardless of the inclusion of pictures. Moreover, for the word alone condition, people in the positive and neutral mood conditions had more false memories compared to those in the negative mood condition. For the recognition of presented items, I observed that people in the negative and neutral mood conditions recognised fewer presented words in the word and picture condition compared to word alone condition. However, when false alarms were taken into account, which assessed the ability to discriminate presented from non-presented items, the effects became non-significant. Overall, I suggest that under normal conditions people in positive and neutral affective states are more likely to process DRM lists relationally, resulting in more false memories. However, when relational processing is disrupted for a given list, false memories can be reduced to the level of false-memory production typical for people in negative moods. Thus, negative mood states are likely to disrupt relational processing resulting in fewer false memories.

GENERAL DISCUSSION

These experiments explored the notion that negative affect enhances memory for item-specific information, which may serve to disrupt relational processing. For Experiments 1 and 2, I observed that people in negative, compared to people in positive and neutral, moods had fewer false memories; however, people in negative, compared to people in positive and neutral, moods had better memory for spatial locations and font styles. In the last experiment, DRM words and pictures were presented together drawing attention to item-specific information. As expected, people in the positive and neutral conditions had fewer false memories. The reduction in false memories suggests that people in the positive and neutral conditions attended to item-specific information, which may have disrupted relational processing. However, the people in the negative mood condition recalled an equal number of critical lures when words were presented alone or with pictures, suggesting that item-specific processing is their default style of processing.

Overall, I observed a consistent effect of mood on encoding and memory; people in the positive and neutral mood conditions recollected more false memories, whereas people in the negative mood conditions recollected more item-specific details. Prior research has only suggested that negative affective cues promote item-specific processing because of reduced false-memory production (Storbeck & Clore, 2005, 2011). In the current research, direct evidence was found supporting that people in negative mood states demonstrated better memory for item-specific features. In addition, when attention was directed to item-specific information during encoding, individuals in positive and neutral moods recollected fewer false memories. Moreover, in Experiments 2 and 3, arousal was controlled for, which suggests these observed findings are due to the valence of the affective state rather than the arousal.

Affect and cognitive processing styles

The focus of this study was to examine whether affect modulates the use of cognitive processing styles. To assess this question of interest, I selected the DRM task because relational or gist processing results in a higher incidence of false memories (Brainerd & Reyna, 2002; Roediger, Balota et al., 2001). The results of the current study supported the fuzzy-trace theory (e.g., Brainerd & Reyna, 2002) and the activation/monitoring framework (e.g., Roediger, Watson et al., 2001). The two theories provide different accounts for the production of false memories. The fuzzy-trace theory is an opponent-processing model that developed out of a dual-trace model of episodic memory, which argues for independence between verbatim (item-specific) and gist processing (e.g., Brainerd, Reyna, & Ceci, 2008; Nelson, McGivney, Gene, & Janczura, 1998; Reyna & Lloyd, 1997; Shiffrin, 2003). Under this model, I would suggest that negative affective states promoted item-specific encoding at the expense of gist processing. The activation/monitoring framework suggests that semantic activation is the primary cause for the activation of critical lures, but more controlled or elaborative processes can also increase false memories. Under this framework, it is possible that negative affective states either disrupt semantic activation and/or disrupt elaborative processes, which could be due to item-specific encoding. Further research is required to distinguish between these two theories, which would be critical for understanding exactly how negative affect reduces false memories.

The implications that affective cues may promote different encoding styles have implications for affective theories. The primary theory behind the research was the affect-as-information approach (Clore, Wyer et al., 2001). This approach suggests that positive affective cues promote relational processing, whereas negative affective cues promote item-specific processing (Clore & Palmer, 2009; Clore, Wyer et al., 2001). The current set of findings would be consistent with this approach. For the first two experiments, the negative affect conditions had higher instances of recollection of item-specific information and lower instances of false memories. Conversely, the positive, compared to negative, affect conditions had higher instances of false memories and lower instances for recollection of item-specific information. As for Experiment 3, false memories were reduced for the positive affect condition when attention was directed toward item-specific information (i.e., pictures), which may have reduced relational processing of list items. Prior research has documented that task situations can override cognitive processing styles generally promoted by affective cues (e.g., Huntsinger, Clore, & Bar-Anan, 2010).

The findings of the current studies are also compatible with cognitive tuning theories (Bless & Schwarz, 1999; Schwarz, 2002; Schwarz & Clore, 2007), the mood and general-knowledge-structure hypothesis (Bless, 2001), and Fielder's (2001) assimilation and accommodation theory. Although these theories have subtle differences, each theory posits that positive affect fosters top-down, heuristic, or assimilative processing styles, whereas negative affect fosters bottom-up, systematic, or accommodative processing styles. Therefore, the present findings would be consistent with each of these theories. Because false memories result from gist, heuristic, or top-down knowledge structures associated with the critical lure, it would be expected that positive, compared to negative, affective states would result in higher instances of false memories, as observed. On the other hand, negative affect promotes bottom-up, systematic, or accommodative processing styles, which would predict fewer false memories, as observed. Moreover, previous research (Bless, Bohner, Schwarz, & Strack, 1990; Bless et al., 1996; Ruder & Bless, 2003) has found that people in positive affective states can override heuristic processing in order to engage in systematic processing, which would provide support for the findings in Experiment 3.

Do affective processing styles influence semantic activation?

Roediger and colleagues suggest that spreading activation within the semantic network is one of the primary causes for false memories in the DRM task (e.g., Roediger, Balota et al., 2001). In addition, the fuzzy-trace theory also suggests that semantic activation (via gist processing) is involved in the production of false memories. In support of this claim, Roediger, Balota et al. (2001) conducted a meta-analysis of their findings and assessed multiple factors to predict false memories. The best predictor was the backward association strength (BAS) of a DRM list. Roediger, Balota et al. (2001) suggested that BAS is an equivalent to activation strength within a semantic network, suggesting that semantic activation underlies the activation and recollection of critical lures.

Semantic activation can be reduced when contextual manipulations that promote attention to surface features are employed. For instance, semantic priming is a paradigm used to examine semantic activation (Neely, 1991). Semantic priming involves briefly presenting a prime word that is either related or unrelated to a target word, and the target is judged on some dimension (e.g., lexical decision). Semantic priming results when related primes facilitate target judgements compared to unrelated primes. Stolz and Besner (1998) found that when attention was directed to individual letters of the prime, semantic priming effects were mitigated. Therefore, attention directed at surface features (i.e., item-specific processing) can impair semantic priming which results from encoding of semantic features.

Just as experimental manipulations can impair priming effects, affective cues can have similar effects on semantic priming. Storbeck and Clore (2008) have found evidence that negative affect reduces semantic priming as well as affective priming effects (Hanze & Hesse, 1993; Storbeck & Clore, 2008). Another study by Corson (2002) also found that negative affect reduced associative priming. Lastly, a study by Vermeulen, Corneille, and Luminet (2007) observed that people in negative affective states performed worse on an extrinsic affective Simon task, suggesting a reduction in semantic processing. These results provide evidence that in various versions of priming tasks, negative affect appears to reduce typically robust priming effects. However, the exact effect negative affect has on semantic activation still remains unclear.

Other effects that rely on semantic priming also find that positive affect enhances and negative affect disrupts such effects. For instance, positive affect facilitates more unusual associations to target words (Isen, Johnson, Mertz, & Robinson, 1985) and more creative answers on a creativity task compared to neutral groups (Isen, Daubman, & Nowicki, 1987). Kuhl and colleagues have observed that positive affect increases the spread of semantic knowledge for intuition or for remote associate judgements (Bolte, Goschke, & Kuhl, 2003). On the other hand, they have found that negative affect reduces the ability to solve intuition or remote associate problems (Baumann & Kuhl, 2002). Thus, positive moods appear to enhance access to semantic associations and elaborative processing.

Given this line of evidence, I suggest that the different processing styles promoted by affective states may have implications for semantic processing. Specifically, relational processing observed in positive affective states may facilitate semantic associations. In the current experiment, this would have increased the susceptibility to recollect critical lures (i.e., false memories) that were never presented. Conversely, item-specific processing promoted by negative affective cues may focus attention to details or surface features. This claim that negative affect directs attention to surface features is bolstered by the findings from the first two experiments, which observed better memory for such information. The attention to item-specific information may have disrupted spreading activation to semantic associates or disrupted gist or elaborative processes. The disruption of semantic activation or gist processing would have reduced the activation of critical lures and the susceptibility to false memories.

Limitations and future directions

There are some limitations with the current research. First, in Experiment 1, the negative mood induction was rather weak in that people self-reported scores that were near the neutral part of the scale. However, the control group did report a happier mood state, suggesting that the baseline affective state may be quite happy (e.g., Diener & Diener, 1996). Therefore, relative to the control group, people in the negative condition were more unhappy. I do note that participants in the negative mood condition for Experiment 2 rated their mood as quite negative, and yet the results conceptually replicated the results from Experiment 1. Further research is required to identify whether there are differences between people who rate themselves less sad relative to their baseline affective state, but not sad enough to self-report scores near the unhappiness end-point of the scale. Second, the manipulations were not designed to directly assess semantic activation. As a result, we cannot determine exactly how negative affect reduces the false-memory effect. Negative affect could prevent semantic activation, it could prevent the use of activated concepts, or it could disrupt gist or elaborative processes. Future research is required to determine the direct effect negative affect has on semantic activation, which may be informative on whether the activation/monitor framework or the fuzzy-trace theory best accounts for current and future results.

Another issue that needs to be addressed is how emotions or moods influence subjective experience within the context of false memories. Subjective experience is known to be influenced by emotions (e.g., LeDoux, 1995; Phelps, 2005; Rolls, 1999), and subjective experience does play a role in the false-memory paradigm. False memories created using the DRM paradigm are powerful because there is an experiential feeling that the non-presented critical lures were actually presented. Work by Brainerd, Payne, Wright, and Reyna (2003) examined this subjective experience and the role it plays in false memory, coining the term phantom recall. Again, the current experiments do not allow for the examination of phantom recall and the associated subjective experience. However, it would be informative to understand how emotion influences subjective experience and whether that influence directly impacts the recollection of false memories.

Conclusions

The findings suggest that negative affect may turn off the default style of processing and trigger item-specific processing. The tuning of an item-specific processing style may be part of a larger cognitive shift to the processing of spatial and action information when negative stimuli or states are present. Research has identified that negative states, such as fear, begin tuning early visual processes to promote low-spatial frequencies rather than high-spatial frequencies (e.g., Bocanegra & Zeelenberg, 2009; Phelps, Ling, & Carrasco, 2006), which is necessary for discriminating visually presented letters/words. Sensitivity toward low spatial frequencies emphasises spatial information and spatial relations. This would facilitate the detection of dangerous entities at the cost of knowing what exactly the object is (e.g., LeDoux, 1996). Moreover, negative affect also tunes executive functions such that spatial working memory becomes more efficient with a negative, compared to a positive, mood induction (e.g., Gray, 2001; Storbeck, 2012). Therefore, negative affect may trigger a shift to perceptual or spatial-based processing starting with early perceptual analysis and ending with executive functions. This shift may come at the cost of semantic or language-based processing as evident in the current study.

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APPENDIX 1

The equations used for both A' and B'' were selected based on the recommendations of Snodgrass and Corwin (1988). Equation for A' (sensitivity) 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, I 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. To calculate a response bias score, B'', I 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).