Research Report

Emotions and False Memories

Valence or Arousal?

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ABSTRACT—***The effects of mood on false memories have not been studied systematically until recently. Some results seem to indicate that negative mood may reduce false recall and thus suggest an influence of emotional valence on false memory. The present research tested the effects of both valence and arousal on recall and recognition and indicates that the effect is actually due to arousal. In fact, whether participants' mood is positive, negative, or neutral, false memories are significantly more frequent under conditions of high arousal than under conditions of low arousal.***

The effects of mood variations on cognitive processes, and specifically on memory, have been widely studied. Isen (1999) proposed that a positive mood, compared with a neutral mood, fosters a richer elaboration of information, leading to a larger number of conceptual relations in semantic memory. Generally speaking, a happy mood favors the use of heuristics, the use of various knowledge structures stored in long-term memory (Bodenhausen, Mussweiler, Gabriel, & Moreno, 2001; Corson, 2002), and the production of new information beyond the available data (Fiedler, 1988). Conversely, subjects in a negative mood appear to make less use of conceptual relations (Ellis, Varner, Becker, & Ottaway, 1995).

Recently, Storbeck and Clore (2005) used the Deese-Roediger-McDermott (DRM) paradigm to investigate the effects of mood on false memories. In the DRM paradigm, subjects are presented with lists of words for recall or recognition. The words on each list are those most frequently produced in response to an inductive word, called the critical lure, in a free-association task (Roediger & McDermott, 1995). After a list has been presented to subjects, the recall probability of the nonpresented critical lure has the recall probability of words located in the middle of the list. Storbeck and Clore tested the hypothesis that a happy mood leads to a higher proportion of false recall of critical lures than sad or neutral moods do. Levels of veridical recall were similar for participants in the three mood groups, but the positive-mood and control groups recalled more critical lures than the negative-mood group did. Thus, the observed difference in false recall of critical lures was due to a lower level of false recall in the negative-mood group, rather than a higher level in the positive-mood group. The authors suggested that gist processing, which is reduced with negative mood, was the mechanism underlying the observed result.

However, Storbeck and Clore's (2005) results need not be interpreted in terms of positive versus negative mood valence, but may instead be interpreted in terms of another distinction between moods (Niedenthal & Halberstadt, 1995). Indeed, several studies have revealed variations in cognitive processing that are associated with different negative emotional states. For instance, sadness favors systematic processing of information, whereas anger promotes heuristic processing identical to what is observed in happy moods (Semmler & Brewer, 2002). In fact, affect is made up of at least two dimensions, valence and arousal, the latter being defined as level of vigilance or activation, varying on a continuum from somnolence to high awakeness (Revelle & Loftus, 1992). In a priming experiment testing the effects of both valence and arousal (Corson, 2006), a mood-induction procedure was used to create two positive-mood groups, one with high arousal (happiness) and one with low arousal (serenity, relaxation), and two negative-mood groups, again one with high arousal (anger) and one with low arousal (sadness). Lexical decision was considerably facilitated in the positive- and negative-mood groups with high arousal, whereas the low-arousal moods did not lead to any facilitation. In addition, the results for a neutral-mood group were equivalent to those for the low-arousal groups.

In the present experiment, we built on previous studies of emotion and false recall in the DRM paradigm by testing the relative effects of valence and arousal on recall and recognition of nonpresented critical lures. If the positive valence of mood is responsible for the false-memory effect in the DRM paradigm, happy (high-arousal) and serene (low-arousal) groups should

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show higher levels of recall and recognition of critical lures than angry, sad, and neutral groups. However, if arousal is the factor that leads to false memories, happy and angry (high-arousal) groups should show more false recall and recognition than serene, sad, and neutral (low-arousal) groups.

EXPERIMENT

Method

The subjects were 222 University of Nantes (France) undergraduates (88% females; mean age = 19) randomly assigned to one of the five mood conditions: 45 in the control condition; 45 in the positive-mood, high-arousal (happy) condition; 40 in the positive-mood, weak-arousal (serene) condition; 48 in the negative-mood, high-arousal (anger) condition; and 44 in the negative-mood, low-arousal (sad) condition.

Ten DRM lists were used. Each consisted of the 15 strongest associates of the critical lure, which were presented to subjects in order from strongest to weakest associative strength. Three random orders of the 10 lists were constructed.

For the recognition test, 60 words were listed in random order in two columns on the last two sheets of paper of the DRM booklet. The 60 words consisted of the 1st, 8th, and 10th items of each of the 10 lists (30 words), the 10 critical lures, and 20 additional words that were unrelated to the 150 words of the 10 lists. Each word in the recognition test was presented with a 4-point Likert scale (4 = *sure that the item was studied*, 3 = *probably studied*, 2 = *probably new*, and 1 = *sure it was new*).

Subjects were run in groups of up to 20 persons. They were told that they would participate in two unrelated experiments and therefore were successively given two booklets, the first one for the mood-induction procedure and the second one for the DRM experiment.

Mood-Induction Procedure

The mood inductions were performed using a composite technique based on music and guided imagery (Mayer, Allen, & Beauregard, 1995). Before and after this induction phase, the subjects filled in the Brief Mood Introspection Scale (BMIS; Mayer & Gaschke, 1988), a 16-item mood adjective scale. Responses to each adjective were made on a 7-point Likert scale.

Following the BMIS evaluation of the mood induction, the subjects were given a matrix consisting of 81 squares (9 lines × 9 columns) and asked to mark one of the 81 squares to report their mood and their arousal. Subjects evaluated the valence of their mood and their arousal simultaneously, using the horizontal dimension of the matrix to indicate valence (with the vertical central column indicating neutral mood) and the vertical dimension to indicate arousal (with the horizontal central column indicating average arousal). The selection of the central square of the matrix, for example, would indicate an average mood associated with an average level of arousal. As noted by Revelle and Loftus (1992), this kind of evaluation seems to accurately reflect the synthesis of several specific physiological measures.

DRM Procedure

After completing the mood-induction procedure, the subjects were told that they would participate in an experiment on memory for lists of words and that they had to recall as many of the words as they could after being presented with each list. The lists were read aloud at a rate of approximately 1 word every 2 s, and subjects were given 1 min to recall each list immediately after it was read. The instructions were to write down the words in the order that they came to mind, without guessing. After subjects recalled the last list, the recognition test was explained, and they filled in the pages of the test. The entire experiment lasted no more than 20 min.

Results and Discussion

Mood-Manipulation Check

The mood manipulation was effective. From the first to the second administration of the BMIS, the ratings for the adjectives describing the induced mood increased, and the ratings for the other adjectives decreased or remained stable. Comparisons within the second set of BMIS ratings showed that the groups were in fairly different moods after the induction procedure. Thus, the adjectives denoting anger were assigned a higher value by the anger group than by the other mood groups, $F(1, 217) = 57.59$, $p_{rep} = .999$, Cohen's $d = 1.27$. Similarly, the sadness group gave higher ratings to the adjectives denoting sadness than the other groups did, $F(1, 217) = 90.70$, $p_{rep} = .999$, $d = 1.28$. In comparison with the sad and angry groups combined, the happy and serene groups gave higher ratings to adjectives denoting a positive valence relative to adjectives denoting a negative valence, $F(1, 217) = 65.13$, $p_{rep} = .999$, $d = 1.67$, and $F(1, 217) = 123.29$, $p_{rep} = .999$, $d = 1.71$, respectively.

The mood-manipulation procedure was equally effective in influencing arousal. As expected, the arousal scores of the five groups differed significantly, $F(4, 217) = 21.85$, $p < .0001$, $\eta = .54$. Ratings for the two high-arousal groups (happy and angry) were clearly different from those for the three low-arousal groups (serene, sad, and control), $F(1, 217) = 68.57$, $p_{rep} = .999$, $d = 1.24$.

Thus, valence and arousal varied considerably across the five mood groups.

Recall

Overall, the mean probability of recall of the studied words was .58, and the critical lures were recalled with a probability of .28. The results for each mood group are shown in Table 1.

Recall of the critical lures was examined using a one-way analysis of variance with mood (happy, angry, serene, sad, control) as a between-subjects factor. The main effect of mood

TABLE 1
Recall and Recognition for Each Item Type and Each Mood Group

	Mean probability of recall		Recognition					
			Mean proportion of items classified as old (ratings 3 and 4)			Mean rating (confidence)		
Mood group	Studied items	Critical lures	Studied items	Unrelated lures	Critical lures	Studied items	Unrelated lures	Critical lures
Control	.57 (.07)	.25 (.15)	.77 (.09)	.02 (.03)	.54 (.23)	3.29 (0.30)	1.17 (0.21)	2.61 (0.62)
Happy	.58 (.07)	.34 (.19)	.77 (.07)	.01 (.02)	.66 (.22)	3.29 (0.29)	1.15 (0.15)	2.94 (0.55)
Angry	.57 (.07)	.36 (.19)	.77 (.09)	.01 (.03)	.64 (.23)	3.33 (0.26)	1.15 (0.16)	2.90 (0.60)
Serene	.59 (.08)	.24 (.14)	.78 (.11)	.01 (.02)	.57 (.23)	3.37 (0.29)	1.15 (0.18)	2.69 (0.63)
Sad	.58 (.08)	.20 (.14)	.76 (.11)	.01 (.04)	.55 (.24)	3.28 (0.28)	1.16 (0.19)	2.64 (0.59)

Note. Standard deviations are given in parentheses.

was significant, $F(4, 217) = 8.03$, $p < .0001$, $\eta = .36$. Planned comparisons showed that the high-arousal groups recalled more critical lures than the weak-arousal groups, $F(1, 217) = 27.39$, $p_{rep} = .999$, $d = 0.82$, whereas the positive- and negative-valence groups did not differ, $F < 1$. Further planned comparisons within each valence showed that the happy group recalled more critical lures than the serene group, $F(1, 217) = 6.74$, $p_{rep} = .950$, $d = 0.56$, and that the angry group recalled more critical lures than the sad group, $F(1, 217) = 23.54$, $p_{rep} = .999$, $d = 1.01$. There were no differences between the high-arousal groups, $F < 1$, or between the low-arousal groups, $F < 1$. Finally, the control group, whose arousal was weak, recalled as many critical lures as the serene and sad groups, $F < 1$, but fewer critical lures than the happy and angry groups, $F(1, 217) = 5.89$, $p_{rep} = .935$, $d = 0.51$, and $F(1, 217) = 10.59$, $p_{rep} = .983$, $d = 0.68$, respectively. Analyses of veridical recall revealed that the five mood groups did not differ, $F < 1$.

Recognition

Recognition data were analyzed by comparing the mean percentage of "old" responses (collapsing across responses of "probably studied" and "sure that the item was studied") across the five mood groups (Table 1). Overall, the hit rate was .77, and the false alarm rate for the unrelated lures was only .01; these results indicate high accuracy. The false alarm rate for the critical lures was .59.

Recognition of the critical lures was examined using a one-way analysis of variance with mood as a between-subjects factor. The difference among mood groups approached significance, $F(4, 217) = 2.33$, $p = .056$, $\eta = .20$. Planned comparisons revealed the same pattern as observed in the recall data: The high-arousal groups classified more critical lures as "old" than the weak-arousal groups did, $F(1, 217) = 6.46$, $p_{rep} = .945$, $d = 0.38$, whereas the positive- and negative-valence groups did not differ, $F < 1$. Moreover, the happy and angry groups classified more critical lures as "old" than the control group did, $F(1, 217) = 5.30$, $p_{rep} = .922$, $d = 0.49$, and $F(1, 217) = 3.84$, $p_{rep} = .878$, $d = 0.41$, respectively, whereas the weak-arousal groups did not differ from the control group. Hit rates and rates of recognition of unrelated lures did not differ across the five mood groups, $F < 1$.

To further investigate the effect of mood on recognition, we compared the mean recognition ratings (confidence) for the five mood groups (Table 1). The hits and unrelated lures prompted identical ratings across the mood groups, $F < 1$. However, the mean ratings of the critical lures differed across the mood groups, $F(4, 217) = 2.97$, $p = .02$, $\eta = .22$. The pattern of results was the same as in the previous analyses: Ratings were higher for the high-arousal groups than for the low-arousal groups, $F(1, 217) = 7.89$, $p_{rep} = .964$, $d = 0.42$, whereas the positive- and negative-valence groups did not differ, $F < 1$. High arousal led to higher ratings than weak arousal did, both in the positive-mood groups, $F(1, 217) = 3.99$, $p_{rep} = .882$, $d = 0.44$, and in the negative-mood groups, $F(1, 217) = 3.89$, $p_{rep} = .878$, $d = 0.42$. In contrast, there was no rating difference in within-valence comparisons of the high-arousal groups (happy vs. angry, $F < 1$) and the low-arousal groups (serene vs. sad, $F < 1$).

DISCUSSION

Underwood (1965) interpreted false recognition in terms of implicit associative response. The idea that false recognition is due to a passive process of automatic associative activation was confirmed by Hutchinson and Balota (2005), who tested false memory for ambiguous and unambiguous critical lures and proposed that false memory in the DRM paradigm reflects lexical activation.

Results obtained with the DRM paradigm have been viewed in terms of the distinction between item-specific and relational processing (Hunt & Einstein, 1981). In this view, negative mood favors item-specific processing, which leads subjects to pay attention to elements of studied items that distinguish them from one another, whereas positive mood helps increase the activation of critical lures by focusing subjects' attention on the commonalities among studied items. Several researchers (Arndt, 2006; Hege & Dodson, 2004) have already emphasized the importance of encoding conditions (i.e., relational vs. item-specific

processing) in accounting for the variations in rates of false memories. However, it must be remembered that the activation process has been shown to be dependent on arousal. For example, certain mood-congruence effects observed for positive moods appear only in high-arousal conditions or disappear when a relaxation session diminishes the level of arousal. Fiedler and Stroehm (1986) suggested that arousal enriches the representation of encoded information. In the same vein, on the basis of the level-of-processing theory, Schwartz (1975) proposed that low arousal is associated with a shallow level of encoding, whereas high arousal favors a more elaborative encoding and an immediate access to information. Moreover, Porter, Spencer, and Birt (2003) obtained results showing that arousal affects suggestibility, which is known to be correlated with the production of false memories. Thus, the effects of mood on false memory need not be due to valence, but could be due to arousal, as whatever participants' mood valence, high arousal leads to more false recall and recognition than low arousal does.

It is important to note, however, that activation is not the only possible explanation for the recall of false lures. Indeed, verbal working memory might be the mechanism underlying the current findings, as the two approach emotions anger and happiness both activate the left prefrontal cortex, which is assumed to be involved in approach (Harmon-Jones, Sigelman, Bohlig, & Harmon-Jones, 2003; Harmon-Jones, Vaughn, Mohr, Sigelman, & Harmon-Jones, 2004). The affect-as-information approach could also offer an explanation, because it proposes that the information conveyed about the validity of the subject's point of view is the critical factor; according to this framework, anger and happiness both lead people to believe that they are correct in their interpretation of the situation, and therefore anger and happiness are expected to have similar effects on performance. Further research is needed to test the relevance of these diverse mechanisms to the production of false memories in the DRM paradigm.

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(Received 4/17/06; Revision accepted 7/19/06;
Final materials received 8/22/06)