Running head:

False memories for emotional DRM lists.

Original title:

Affective valence influences participant's susceptibility to false memories and illusory recollection

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ABSTRACT

This study examined the influence of emotional valence on the production of DRM false memories (Roediger & McDermott, 1995). Participants were presented with neutral, positive or negative DRM lists for a later recognition (Experiment 1) or recall (Experiment 2) test. In both experiments, confidence and recollective experience (i.e., "Remember-Know" judgements; Tulving, 1985) were also assessed. Results consistently showed that, compared with neutral lists, affective lists induced more false recognition and recall of non presented critical lures. Moreover, although confidence ratings did not differ between the false remembering from the different kinds of lists, "Remember" responses were more often associated with negative than positive and neutral false remembering of the critical lures. In contrast, positive false remembering of the critical lures was more often associated with "Know" responses. These results are discussed in light of the Paradoxical Negative Emotion (PNE) hypothesis (Porter et al., 2008).

KEYWORDS: Emotion, False Memory, False Recall, False Recognition, Illusory recollection

Psychologists are now well aware of the constructive nature of human memory (e.g., Schacter, 1999; 2001). Indeed, it has been largely established that our memories are not perfect pictures of the past that are stored and left unaffected somewhere in the brain. Rather, memories are malleable, often deviate from what actually happened and are not free from errors (e.g., Bartlett, 1932; Conway, 1997; Johnson, Hashtroudi & Lindsay, 1993; Roediger, 1996; Schacter, 2001). These memory errors can be divided in two main categories: forgetting and distortions. While forgetting has been vastly studied for a number of decades, memory distortions have only received particular attention the past 15 years. This strong interest was, at least in part, motivated by the controversy related to the possibility that adults may produce false memories of childhood sexual abuse (e.g., Loftus & Ketcham, 1994; Schacter, 2001) and also by more applied cognitive studies assessing the reliability of eyewitness testimony (e.g., Loftus, 1979; Loftus et Ketcham, 1991; Wells et Olson, 2003).

Consequently, numerous paradigms have been designed to study false memories in the laboratory in order to examine the factors responsible for false memory production or that contribute to memory distortion resistance (e.g., Gallo, 2006; Koriat, Goldsmith & Pansky, 2000). Robust findings showed that memory distortions comprise a wide variety of phenomena ranging from the distortion of particular elements or details of an actually experienced event, to the remembering of entire events that have never occurred (e.g., Roediger, 1996). Indeed, on the one hand, it has been repeatedly shown that the information to which a witness is exposed after a witnessed event can be strongly detrimental to its later memory accuracy and may be incorporated into his/her report (e.g., Ayers & Reder, 1998; Loftus, Miller & Burns, 1978; Zaragoza & Lane, 1994). On the other hand, a large body of research has also demonstrated that it is possible to implant false memories of entirely new events with the use of suggestive narratives (e.g.,

Loftus & Pickrell, 1995; see for a review, Garry & Gerrie, 2005) associated or not either with doctored photographs (e.g., Wade, Garry, Read & Lindsay, 2002) or true photographs (e.g., Lindsay, Hagen, Read, Wade & Garry, 2004).

Thus, research has shown that it is possible to make people falsely remember events that have never occurred. Moreover, these false memories may be quite compelling as individuals often remember vivid details associated with the supposed occurrence of the events (e.g., Gallo, 2006; Wade et al., 2002; Loftus & Palmer, 1974), an intriguing phenomenon called "Illusory Recollection". These effects have been shown in a variety of conditions and populations (see for instance, Gallo, 2006; Koriat et al., 2000). However, despite the fact that the interest in false memories was associated with legal cases typically involving negative events, it is only recently that emotion has been taken into account in the production of memory distortion. Indeed, for a long time, studies have examined whether emotional information is more likely to be remembered than neutral information (see Mather, 2007 for a synthesis). The findings are mixed and seem to strongly depend on what aspect of the stimulus was considered (i.e., central or peripheral details). Nevertheless, the aspect of accuracy was not the topic of interest until recent years and data seem to concur showing that negative emotion might influence the production of false memories. Indeed, the effects of misinformation (i.e., the impairment of accuracy due to the presentation of misleading information after a target event) appear more likely for negative events than neutral events (e.g., Nourkova, Bernstein & Loftus, 2004; Porter, Spencer & Birt, 2003; Porter, Yuille & Lehman, 1999). In addition, implanted memories seem to be more often recalled when the target event was negative than neutral or positive (e.g., Hyman, Husband & Billings, 1995; Otgaar, Candel & Merckelbach, 2008).

One explanation of these effects is provided by the Paradoxical Negative Emotion (PNE) hypothesis recently put forward by Porter and colleagues (e.g., Porter, Taylor & ten Bricke, 2008). Following this proposal, evolution has modelled our brain so that although negative events should be better remembered to avoid future dangers, they are also more sensible to distortion because there is an adaptive value for individuals to include more information about future dangers from various sources. For instance, it is more important to remember what you did to survive an assault compared to remembering what the perpetrator or the environment looked like. Consequently, negative information is more likely to be recalled over time but is also more vulnerable to memory distortions than other kinds of information (i.e., positive and neutral information; see also Schacter & Addis, 2007).

The aim of the current study is to examine the Paradoxical Negative Emotion hypothesis through another procedure largely used to study false memories in the lab: the DRM paradigm (Roediger & McDermott, 1995). In this procedure, participants are typically presented with lists of associated words (e.g., thread, pin, eye, sewing…) that converge on non-presented critical lures (e.g., needle). Later, they frequently falsely recall or recognize the non-presented critical lures at high rates and claim to recollect very specific details about their occurrence in the study list. Indeed, participants are often very confident that the critical lure has occurred and are able to provide descriptions and details regarding its presentation even though it has never been presented (e.g., Lampinen, Neuschatz & Payne, 1998, Lampinen, Meier, Arnal & Leiding, 2005; Mather, Henkel & Johnson, 1997; Norman & Schacter, 1997). Following the activation-monitoring account (e.g., Gallo & Roediger, 2002; McDermott & Watson, 2001; Roediger, Watson, McDermott & Gallo, 2001), false memories in this paradigm are thought to occur because, during the presentation of the list, the critical lure is activated

as a result of a spreading of activation in an associative network that will subsequently result in its easier accessibility (McDermott & Watson, 2001; Roediger & McDermott, 1995). During retrieval, this activation must be correctly attributed to the participant's own thoughts and not to the item's occurrence in the list through a successful "reality monitoring" process (Johnson, Hashtroudi & Lindsay, 1993; Johnson & Raye, 1981). Although the ecological validity of false memories produced by the DRM paradigm has been criticised (e.g., Freyd & Gleaves, 1996, Pezdek & Lam, 2007; Wade et al., 2007), the DRM paradigm has nevertheless proven to be a very useful tool to understand the mechanisms underlying false memory production and/or resistance (e.g., Gallo, 2006). Hence, if poor source monitoring is responsible for false memory production in the DRM paradigm, and if emotional information (and especially negative information following the PNE hypothesis) is more likely to induce source confusions, then emotion should affect participants' performance in the DRM paradigm. To our knowledge, however, only a few studies have examined the influence of emotion on the production of false memories in the DRM paradigm, and the findings in these studies are inconsistent.

EMOTION AND DRM PARADIGM

In a pioneer study, Pesta, Murphy & Sanders (2001) examined whether emotional critical lures could be falsely remembered. They presented adults with orthographic associates of either emotional (e.g., bitch) or non emotional (e.g., shave) words. Results showed that emotional lures were less falsely recognized than non emotional words. In addition, they showed that the distinctiveness of the emotional lures was the key factor. That is, including other emotional items during encoding (thereby decreasing the distinctiveness of the emotional lure words) increased the likelihood of false recognition for emotional words and increased the proportion of participants whose false responses to emotional lures were "remember" type responses, as compared with neutral lures.

Nonetheless, the rates of emotional false recognition did not approach the rates of false recognition of the non-emotional lures. Thus, the participants seemed to benefit from the distinctiveness provided by emotion (see also Huang & Yeh, 2006; Kensinger & Corkin, 2004).

In contrast, Budson and colleagues were interested in whether false recognition of emotional lures would also be lower than that of non-emotional lures if study lists were related to the lures semantically rather than orthographically (Budson, Todman, Chong, Adams, Kensinger, Krangel & Wright, 2006). They presented negative and non-emotional DRM lists that were equivalent for word length and frequency. Results showed that emotional studied words were more likely to be recognized than non-emotional words whereas there was no reliable effect of emotion on false recognition of the critical lures. Nevertheless, one limit of their study is that they did not control for false alarms as no emotional distractors were presented during the recognition task. Another limit is that, while the emotional versus neutral lists were matched on frequency and word length, it is not known whether they were also matched on mean associative strength or in terms of identifiability of the critical lures, both factors known to affect the production of false memories (e.g., Gallo & Roediger, 2002; Neuschatz, Benoit & Payne, 2003; Roediger, Watson, McDermott & Gallo, 2001).

Accordingly, Howe (2007) recently equated emotional and neutral lists on familiarity and associative strength and found that false recall was higher for neutral than for negative emotional lists, whereas false recognition was higher for negative emotional lists than for neutral items. However, because this study only included children (i.e., 8 and 12 year-old children), it is difficult to generalize these findings to adults. Finally, El Sharkawy and colleagues presented neutral and negative DRM lists to adults for a free recall phase followed (after a few minutes) by a recognition test (El Sharkawy, Groth,

Vetter, Beraldi and Fast, 2007). While they found no effect of valence on correct recall, recall of the critical lures, intrusions, correct recognition or false alarms, they observed significantly more false recognition of the negative critical lures compared to neutral critical lures. However, word length and concreteness differed between negative and neutral DRM list, so these factors may have increased the rates of false recognition in negative lists (e.g., Hirshman & Arndts, 1997; Perez-Mata, Read & Diges, 2002), independently of an effect of negative valence per se.

OVERVIEW OF THE CURRENT EXPERIMENTS

To summarize, there is no convincing evidence to determine whether emotional events may undergo memory distortions to a greater or lesser extent than neutral information with semantic DRM lists. Indeed, in the studies that examined the influence of emotion on the classical DRM material (i.e., lists composed of semantic associates), one study included children as subjects and the others did not match the lists on various material characteristics such as associative strength, concreteness, word length and identifiability of the critical lures. In addition, there were no indications regarding the overall arousal of the lists in any of the studies. As such, some items might have been more arousing than others thereby increasing their distinctiveness (e.g., Pesta et al., 2001).

The aim of our study was to specifically examine the influence of affective valence on the production of false memories. We wanted to test whether valence would affect the recognition of critical lures if study lists were related to the lures semantically rather than orthographically, and were better matched on factors that may influence false memories production (such as arousal, concreteness, familiarity, associative strength, etc.). In addition, we also specifically contrasted negative and positive DRM lists in our experiments to test further the Paradoxical Negative Emotion hypothesis as, following

this hypothesis, negative information should be more susceptible to distortion compared to positive and neutral information.

Hence, in a first experiment, we presented participants with positive, negative and neutral DRM lists and tested their memory for recognition to determine the influence of valence on false memory production. In a second experiment, we wished to examine whether the results also extend to a recall task. In addition, in this second experiment, we used a modified DRM procedure (Brédart, 2000) to better determine the locus of this influence. That is, we examined whether the influence of affective valence on false memories production is associated with a greater interconnectivity in emotional information (Talmi et Moscovitch, 2004; Talmi, Luk, McGarry & Moscovitch, 2007), which would lead to a greater activation of the critical lures in these conditions compared to neutral lists, or whether affective valence would affect the efficient monitoring of the critical lure in a greater extent in emotional lists (Brédart, 2000; Dehon, 2006; Dehon & Brédart, 2004) in comparison with neutral lists. In addition, in both experiments, we also examined the influence of valence on illusory recollection (i.e., the recollection of details associated with the supposed presentation of the falsely recognized or recalled critical lures) through confidence ratings and "Remember-Know" judgments (e.g., Tulving, 1985). Indeed, DRM false memories are typically subjectively compelling and not simply based on a strong feeling of familiarity as subjects often claim to be able to recollect details related to the supposed presentation of the critical lures.

EXPERIMENT 1: The influence of affective valence on false recognition.

In this experiment, we examined the influence of emotion on the production of false recognition and on the phenomenological information associated with veridical and false memories in the DRM paradigm. We presented negative, positive and neutral DRM lists for a later OLD/NEW recognition test during which we also assed whether participants

were confident in their responses (confidence ratings) and whether they could recollect anything specific about the presentation of their recognized response ("Remember" judgement) or just based their responses on a strong feeling of familiarity ("Know" judgement; Tulving, 1985).

We hypothesized that studying lists of associates that share semantic and emotional similarities should make emotional critical lures less distinctive and false recognition of emotional critical lures should be higher than that of neutral critical lures (e.g., Huang & Yeh, 2006; Pesta et al., 2001). In addition, converging similarities between study items and critical lures in emotional lists might also affect the efficient binding of target and context information (Henkel & Franklin, 1998; Johnson & Chalfonte, 1996). In this case, contextual information associated with one presented item may be associated with another highly similar item (for instance, the critical lure) and the source of the two memories may be confused (Henkel & Franklin, 1998; Henkel, Franklin & Johnson, 2000). This, in turn, may lead to higher rates of false recognition of the critical lures that would be held with confidence and high rates of illusory recollection (i.e., "Remember" judgements assigned to falsely recognized critical lures; e.g., Brainerd, Wright, Reyna, & Mojardin, 2001; Gallo & Roediger, 2003; Lampinen et al., 2005) in the emotional DRM lists compared to neutral lists. As such, we hypothesized that critical lures from both positive and negative DRM lists should be falsely recognized more often than neutral lists. In addition, we hypothesized higher confidence ratings and more "Remember" judgements assigned to emotional lures than to neutral lures. However, following the predictions of Paradoxical Negative Emotion hypothesis (Porter et al., 2008), this effect should be more important in negative DRM lists compared to positive and neutral DRM lists.

METHOD

Participants. Thirty-six undergraduates (16 females) from the University of Liège, aged between 18-28 years old (M= 21.59, SD= 2.72), participated in the experiment. Subjects were approached for their co-operation, which was voluntary and was not required for course credit. No incentive was offered for participation. None of the volunteers had a previous history of mental illness, alcohol or drug abuse. In addition, participants were screened for depression and anxiety, which resulted in the removal of 4 participants due to their high scores on the depression and/or the anxiety scale.

Materials and procedure. French DRM lists of 12 items were constructed for each valence. To this purpose, a group of 65 participants generated free associations to 36 critical items (12 for positive lists, 12 for neutral lists and 12 for negative lists). The resulting 36 lists were extensively piloted on independent groups of participants. Different groups of participants were presented with the generated lists and either evaluated: (1) the associative strength measuring how well a list item was associated with its theme word on a 7-point scale (ranging from 1 “not associated with the theme word” to 7 “strongly associated with the theme word”; n= 50; 25 females), (2) the level of arousal of the words (the critical items were also included) on a 9-point scale (ranging from 1 “calming” to 9 “exciting”; n = 42; 20 females), (3) the level of imagery (how easy it is to make a mental image of the concept represented by the word; on a 7-point scale ranging from 1 ”very easy” to 7 “very difficult”; n= 42; 22 females) and the critical item was also evaluated on this dimension; (4) the degree of identifiability (i.e., the participants were presented with the list words rearranged in decreasing order of association but without the critical lure and they had to come up with the word that “tied up” all the other words in the list together; n= 36; 17 females), and finally (5) the valence of the words on a on a 9-point scale ranging from -3 “negative” to 5 “positive”; n= 48; 24 females).

From these pilot studies, we obtained 4 DRM lists for each valence that were equivalent for word length [*F(2,22)= 2.50, MSe= .22, p= .10,* η_p^2=.18], frequency (*F<1*), imagery (*F<1*), level of arousal (Mean Neutral: 4.8 $\pm$ 0.51, Negative: 4.85 $\pm$ 0.85 and Positive lists: 4.83 $\pm$ 0.72; *F<1*), associative strength (Mean Neutral: 4.43 $\pm$ 0.52, Negative: 4.38 $\pm$ 0.73 and Positive lists: 4.39 $\pm$ 0.37; *F<1*) and identifiability [*F(2,22)= 2.10, MSe=.06, p= .85,* η_p^2=.01]. The critical lures in the different lists were also matched on these dimensions. As expected, the lists only differed on valence ratings (Mean Neutral: 1.25 $\pm$ 1.28, Negative: -1.85 $\pm$ 1.14 and Positive lists: 3.85 $\pm$ 1.62; *F(2,22)= 45.60, MSe= 1.87, p <.0001,* η_p^2=.80). The critical lures (English translations of these French words are in brackets) for these lists were "odeur" (*odor)*, "dessin" (*drawing)*, "temps" (*time)*, and "musique" (*music)* for the neutral lists, "tristesse" (*sadness)*, "peur" (*fear)*, "esclave" (*slave)* and "guerre" (*war)* for the negative lists and "courage" (*courage)*, "force" (*strength)*, "vacances" (*holidays)* and "chance" (*luck)* for the positive lists (see appendix).

Finally, to ensure that our lists were similar in terms of inter-item association (i.e., a measure of connectivity between the words in a list of associates), we made a last pilot study in which 55 participants (29 females) were tested individually and were presented with all the words of the 12 lists chosen as the to-be-remembered material, except the critical lures. The associated words were presented pseudo randomly for each participant (that is, 2 words from the same list could not be presented successively and had at least 2 items from the other lists between them). The participants were asked to make free associations for these words. More specifically, the participants were presented with each word individually and were asked to give the first word that comes to mind. From these evaluations, we computed a measure of connectivity (see, McEvoy, Nelson & Komatsu, 1999) that represents the number of shared connections per associates within each DRM

list. We compared the mean shared connections between the lists and found that the three kinds of lists were similar in terms of mean connectivity (Mean Neutral: 1.30 $\pm$ 0.52, Negative: 1.27 $\pm$ 0.38 and Positive lists: 1.25 $\pm$ 0.41; $F<1$). In addition, the lists were checked to ensure that the content of each list does not contaminate the content of the other lists.

Participants were tested individually. They were told that the experimenter would read 12 lists of 12 words and that their memory would be tested after they learned all the lists. The 12 lists were presented in a random order for each participant. However, within each list, the words were read aloud by the experimenter from the highest to the lowest associate, and at a rate of one word per 1.5 s. After having heard all the lists, the experimenter started to explain the recognition test procedure (which took about 3 minutes).

The recognition test was composed of 48 studied items (position 1, 4, 8 and 10 of each of the 12 studied lists; later referred to as “studied”), 48 non-studied control items (matched to the 48 studied items for frequency, word length, valence and arousal; “FAs”), 12 non-studied critical lure items (1 for each studied list; “critical lures”) and 12 non-studied critical control items (matched to the 12 non-presented critical lure items for frequency, word length, valence and arousal; “FAcl”). We used two kinds of distractors (FAs and FAcl) as previous studies showed that critical lures sometimes have particularities that make them more susceptible to be falsely recognized even when their corresponding lists were not presented (see Gallo, 2006). Participants were presented with a sheet of paper with the 120 items of the recognition test. They were invited to circle the items that they remembered having been read by the experimenter during the presentation of the lists. The experimenter strongly encouraged the participants to avoid guessing and asked them to be relatively sure of their responses.

Next, they were instructed to rate their confidence in having heard the word on a 5-point scale (1 = not very confident, 3 = fairly confident, 5 = extremely confident that the experimenter produced the word). After this phase, the participants were invited to determine whether they could recall any specific detail related to the presentation of the items they had just recognized ("Remember-Know" judgments, Tulving, 1985). The participants were asked to use a "Remember" judgment when they could consciously recollect details of the actual occurrence of the word and to use a "Know" judgment when they were confident that the item was presented in the list but could not remember anything about its presentation (Rajaram, 1993). Finally, the participants were thanked for their participation and were fully debriefed.

RESULTS AND DISCUSSION

For all the following analyses, the alpha level was set at .05. Descriptive data are presented in Table 1.

Please insert Table 1 about here

A two-way ANOVA 3 (List type: neutral vs. negative vs. positive) X 4 (Response type: studied, critical lure, FAs and FAcl) with repeated measures on the two factors was carried out on the mean proportions of old responses across the lists (see top Table 1). The main effect of List type was marginally significant *[$F(2,62)= 2.83$, $MS_e= .03$, $p=.07$; $\eta_p^2= .08$]*. This effect showed that the proportion of old responses to negative lists (M=.31, SD= .11) was significantly higher than the proportion of old responses to neutral lists (M= .26, SD= .10). However, neutral and positive lists (M= .30, SD= .09) did not differ in terms of the proportion of old responses and there was no difference between the proportion of old responses to negative lists and positive lists. The analysis also revealed a significant main effect of Response type *[$F(3,93)= 219.71$, $MS_e= .04$, $p<.0001$; $\eta_p^2=.88$]*. Planned comparisons showed that the proportion of old responses to studied

(M= .54, SD= .11) and critical items (M= .53, SD= .19) were similar and were significantly higher than the proportion of false alarms to the distractors matched to studied items (FAs, M= .04, SD= .04) or matched to critical lures (FAcl, M= .03, SD= .07). The proportions of old responses did not differ between FAs and FAcl items. Finally, a significant List type X Response type interaction *[F(6,186)= 2.76, MS_e= .03, p=.014; η_p^2= .08]* was also revealed. This interaction showed that the proportion of old responses to studied items was not influenced by the List type (see Table 1). However, the proportion of old responses to critical lures from negative lists and positive lists were similar and were much higher than the proportion of old responses to critical lures from the neutral lists.

A two-way ANOVA 3 (List type) X 2 (Response type) with repeated measures on the two factors was also carried out on the corrected recognition scores (studied items minus FAs and critical lures minus FAcl) and revealed a significant List type X Response type interaction *[F(2,62)=5.41, MS_e= .03, p< .01; η_p^2= .05]* showing again that the proportion of old responses to studied items was not influenced by the List type (M= .51, SD= .18; M= .52, SD= .20; and M= .47, SD= .14, for neutral, negative and positive lists, respectively). However, the proportion of old responses to critical lures from negative lists (M= .55, SD= .30) and positive lists (M=.55, SD= .26) were similar and were much higher than the proportion of old responses to critical lures from the neutral lists (M= .39, SD= .35). The main effect of List type *[F(2,62)= 1.67,MSe= .08, p=.20; η_p^2=.05]* and the main effect of response type *[F<1]* were not significant.

Next, a two-way ANOVA 3 (List type) X 2 (Response type) with repeated measures on the two factors was carried out on the mean confidence ratings assigned to studied items and critical lures (see middle of Table 1). Because of the low frequencies of erroneous recognition, the confidence ratings assigned to FAs and FAcl were not

included in the analysis. A significant main effect of Response type *[F(1,21)= 6.99, MSe=.67, p= .015; η_p^2=.25]* was observed showing that the mean confidence rating assigned to studied items (M= 4.18, SD= 0.36) was higher than that assigned to the critical lures (M= 3.69, SD= 0.93). No main effects of List type or List type X Response type interaction were found *[all Fs < 1]*.

A two-way ANOVA 3 (List type) X 2 (Response Type: Hits vs. Critical lures) with repeated measures on the two factors was carried out on the mean proportions of "Remember" judgements assigned to old responses (see Table 1). The main effect of List *[F(2,62)= 0.78, MSe=.07, p=.46, η_p^2= .02]* and the main effect of response type *[F(1,31)= 0.39, MSe=.05, p=.09, η_p^2= .01]* were not significant. However, the significant List x Response Type interaction *[F(2,62)= 4.85, MSe=.02, p=.01 ; η_p^2= .14]* was significant and showed that similar proportions of "Remember" judgements assigned to hits were produced for negative, positive and neutral lists. In contrast, the proportion of "Remember" responses assigned to negative false memories (M= .41, SD= .32) was significantly higher than that assigned to both neutral (M= .28, SD= .33) and positive (M= .27, SD= .20) false memories that did not differ to each other.

The same analysis made on "Know" judgements assigned to old responses corrected for independence (i.e., proportion of corrected "Know" judgements = proportion of "Know" judgements / [1-proportions of Remember judgements]; Yonelinas & Jacoby, 1995) revealed no significant main effect Response Type *[F<1]*with similar proportions of corrected "Know" judgements assigned to hits (M= .30, SD= .13) and to critical lures (M= .29, SD= .20). The main effect of List was significant *[F(2,62)= 3.53, MSe=.08, p=.03 ; η_p^2= .10]* and showed that the proportion of corrected "Know" judgements assigned to neutral lists (M= .22, SD= .20) was significantly lower compared to the proportions assigned to both positive (M= .33, SD= .23) and negative (M= .34,

SD= .21) lists. Finally, a significant List X Response Type interaction *[F(2,62)= 3.29, MSe=.05, p=.04 ; η_p^2= .10]* revealed that the proportions of corrected "Know" judgements assigned to hits from negative lists (M= .37, SD= .19) were significantly higher than the proportions assigned to both positive (M= .28, SD= .17) and neutral lists (M= .25, SD= .18), that did not differ to each other. The proportion of corrected "Know" judgements to false memories from positive lists (M= .40, SD= .33) was significantly higher than that assigned to false memories from neutral lists (M= .20, SD= .29) but not different from the proportion assigned to false memories from negative lists (M=.31, SD= .38). The proportions of corrected "Know" judgements assigned to neutral and negative false memories were not statistically different.

Overall, the results showed that emotional valence did not affect correct recognition and the subjective experience of remembering ("Remember judgments") associated with correct performance. However, studied items recognized on the basis of familiarity ("Know" judgments) seemed to be more frequent in negative lists compared to the other kinds of lists. In contrast, although emotional and non-emotional lists elicited false recognition of their associated critical lures, the proportion of false recognition of the critical lure elicited by emotional lists (i.e., negative or positive lists) was higher than in neutral lists. In addition, whereas no effects on the confidence ratings assigned to falsely recognized critical lures were found, "Remember" and "Know" judgements provided interesting results as they distinguished emotional false recognitions. That is, lures falsely recognized on the basis of familiarity were statistically more frequent in positive lists (but only numerically in negative lists) compared to neutral lists. However, falsely recognized critical lures from negative lists were more often accompanied by "Remember" responses than critical lures from both positive and neutral lists. As such, these data support the

Paradoxical Negative Emotion hypothesis that false memories, in the sense of compellingly vivid memory distortions, are observed more often in negative lists.

These data suggest that emotional material may induce more source monitoring errors in the DRM procedure compared with neutral material. However, little is known as to whether these effects are related to a greater probability to activate the critical lures in emotional lists because they are more semantically cohesive (e.g., Talmi & Moscovitch, 2004; Talmi, et al., 2007). In this case, one would expect them to activate the critical lure more easily in the participant's mind due to their greater interconnectivity. In contrast, a reduced distinctiveness in emotional lists (due to the various associates presented at study that shared both semantic and affective similarities) would make source decision more difficult in comparison with neutral lists. Thus, the aim of the next experiment was to determine, first, whether the effects obtained in recognition also extend to recall and, second, whether emotional lists, and especially negative lists, influence the activation of the critical lures and/or render monitoring processes less efficient due to a reduce distinctiveness in comparison with neutral lists.

EXPERIMENT 2: The influence of affective valence on false recall.

DRM false memories are thought to occur because, during the presentation of the list, the critical lure is activated as a result of a spreading of activation in an associative network that will subsequently result in its easier accessibility (e.g., McDermott & Watson, 2001; Roediger & McDermott, 1995). During retrieval, this activation must be correctly attributed to the participant's own thoughts and not to the item's occurrence in the list through a successful "reality monitoring" process (e.g., Johnson et al., 1993). In this second experiment, participants were presented with neutral, negative and positive DRM lists in a modified DRM procedure (Brédart, 2000; Dehon, 2006; Dehon & Brédart, 2004) designed to obtain estimates of activation and successful source monitoring of the

critical lures. That is, after the memory test (e.g., a recall task), participants were asked to say if, during the learning phase or during the recall phase, a word came to their mind, but they did not write it down during the recall task because they thought the experimenter had not produced it. This modification allowed us to examine the distribution of the critical lures throughout the experiment and to determine the best explanation as to why, for some trials, false memories did not occur (i.e., due to successful monitoring versus an activation failure). Specifically, a failure to recall a critical lure either in the initial recall phase or during the added phase suggests that the list failed to evoke it. On the other hand, the reporting of a critical lure during the added phase for a list that did not initially produce a false memory is indicative of successful monitoring.

Emotion may influence the criteria employed in source monitoring decisions because the studied associates in these lists share both emotional and semantic similarities, which make the critical lure less distinctive compared to neutral lists (e.g., Budson et al., 2006). In these conditions, we expected participants to recall more emotional critical lures during the memory task, and less emotional critical lures during the added phase (estimating source monitoring) than neutral critical lures. In contrast, other things being equal, emotional lists are thought to be more semantically cohesive (e.g., Talmi & Moscovitch, 2004; Talmi, et al., 2007). In this perspective, emotional categories are categories in which constituent items share strong inter-item associations. Consequently, if constituent items are more interconnected in emotional lists than in neutral lists, one would expect them to activate the critical lure more easily in the participant's mind compared to neutral lists. In these conditions, differential rates of activation between emotional and neutral lists should be observed. In other words, the

higher rates of false recall for emotional lists would be due to their higher susceptibility to evoke the critical lure in the participant's mind compared with neutral lists.

METHOD

Participants. Fifty-four undergraduates (30 females) from the University of Liège, aged between 19-26 years old (M= 20.21, SD= 1.78), and selected with the same constraints as in Experiment 1, participated in the experiment. Twenty-four were assigned to a "no judgements" condition and 30 to a "recollective judgements" condition. The experimental details of these conditions are presented below.

Material and Procedure. We used the same material as in Experiment 1. The participants were tested individually. They were told that the experimenter would read 12 lists of 12 words and that they would be tested for each list after having counted backward by 3's for 30 seconds. The lists were presented in a random order for each participant. The words were read aloud by the experimenter at a rate of one word per 1.5 s. For each recall phase (Phase 1), the participants were instructed to recall as many words as possible from the list they had just heard. They were then asked to write down the words on a sheet of paper in any order, but without guessing (Brédart, 2000). They were given 90 seconds to complete each recall phase. After having recalled all the lists, a first post-recall task was administrated to the participants. In this task (Phase 2), they were instructed to rate their confidence in having heard the word in the list they had just heard on a 5-point scale (1 = not very confident, 3 = fairly confident, 5 = extremely confident that the experimenter produced the word). Next, they were invited to determine whether they could recall any specific detail related to the presentation of the items they had just recalled ("Remember-Know" judgments, see previous experiment). In a second post-recall phase (later referred to as "added phase"), they were instructed to say if, during the learning phase or during the recall phase, a word came to their mind but they

did not write this word down during the recall task because they thought the experimenter had not produced it. Then, the participants were successively presented with the word lists they recalled in the first phase and they were asked to write down (with a different colored pen) any other words they had thought of for that list. In this phase, the participants were instructed to only write down words they remembered having thought of during the presentation of the lists and not to infer or to guess the words from the current instructions. During a final phase, they were asked to assign a rating that reflected their confidence in NOT having heard the experimenter produce that thought word on a 5-point scale (1= not very confident, 3= fairly confident, 5= extremely confident that the experimenter did not produce the word). Finally, the participants were thanked for their participation and were fully debriefed.

Because the confidence ratings and the "Remember-Know" judgements occur between the learning of all the lists and the beginning of the added phase, one[1] might argue that these judgements and/or the difference in time spent between the two tasks may influence the participants' monitoring abilities in comparison with a condition in which these judgements were not made between the learning of the lists and the added phase. To test this hypothesis, we compared the results of two different versions of the procedure: the "no judgements" condition (n=24 participants, 12 females) and the "judgements" condition (n=30 participants, 20 females). However, because the "no judgements condition" had no effect on its own, did not change the pattern of results or did not interact with any of the variables, only the results of the "judgements" condition will be presented in the next section.

RESULTS AND DISCUSSION

[1] We thank one of the anonymous reviewers for bringing up this suggestion.

For all the following analyses, the alpha level was set at .05. Descriptive data are presented in Table 2 (mean proportions of recall) and in Table 3 (mean confidence ratings and proportions of "Remember" responses).

Performance in recall and subjective ratings. A one-way ANOVA (List type: neutral vs. negative vs. positive) with repeated measures was carried out on the proportions of studied items recalled. This analysis revealed no significant effect of List type *[F<1]* suggesting that emotional items were not better recalled than neutral items (see table 2). The same analysis made on the proportions of critical lures recalled by each participant across the lists showed that in comparison with neutral DRM lists, positive and negative DRM lists elicited higher proportions of false recall *[F(2,58)= 7.42, MSe= 0.05, p<.01;* η_p^2*= .20]*. Non-critical intrusions (i.e., intrusions other than the critical lure) were similar regardless of the list type *[F<1]*. Because the frequency of these intrusions was very low (M=.02, SD= .06; M= .03, SD= .05 and M= .02, SD= .05 for neutral, negative and positive lists, respectively) and much lower than the frequencies of veridical and false recalls, they were not included in the next analyses.

Please insert Table 2 about here

A two-way ANOVA 3 (List type) X 2 (Response type) with repeated measures on the two factors was carried out on the mean confidence ratings assigned to studied items and critical lures (see top Table 3). This analysis only revealed a significant main effect of Response type *[F(1,13)= 13.72, MSe =1.71, p<.01;* η_p^2*= .51]*showing that the confidence ratings assigned to the studied items (M=4.60, SD= 0.35) were significantly higher than the confidence ratings assigned to the critical lures (M=3.43; SD= 1.42). No other significant effects were found (all *Fs<1*).

A two-way ANOVA 3 (List) X 2 (Response: studied vs. critical lure) with repeated measures on the two factors was carried out on the mean proportions of

"Remember" judgements assigned to studied and critical lures (see bottom Table 3). The main effect of List *[F(2,58)=4.62, MSe=.02, p<.01; η_p^2= .14]* was significant and showed that the participants assigned higher proportions of "Remember" judgements to negative lists (M=.29, SD= .11) than to both neutral (M=.23, SD= .09) and positive lists (M=.25, SD= .13). The main effect of Response was significant *[F(1,29)=21.70, MSe=.05, p<.0001; η_p^2= .43]* and showed that studied items (M=.33, SD= .11) received more remember judgements than critical lures (M=.18, SD= .14). The List type X Judgement interaction was also statistically significant *[F(2,58)=9.87, MSe=.02, p<.001; η_p^2= .25]*. Planned comparisons showed that the proportion of "remember" judgements was similar for studied items from neutral, negative and positive lists. In contrast, false memories for positive and negative lists received more "remember" judgements than false memories from neutral. But the proportion of "Remember" judgements for negative false memories was significantly higher than that of false memories from positive lists.

The same analysis was carried out on the proportions of corrected "Know" judgements (see previous experiment) assigned to studied and critical lures. Typically, in this context, whenever participants made know judgments, they explained during the debriefing that they were sure that the word had been presented but that they could not remember whether they thought of something or could not remember what they thought for that word (e.g., personal association or emotional responses) or whether they could remember whether it was presented in the beginning or the end of the list or which word came before or after it. A significant main effect of response *[F(2,58)=9.87, MSe=.02, p<.001; η_p^2= .25]* revealed that more "Know" judgments were assigned to studied items (M=.32; SD= .14) compared to critical items (M=.20; SD= .15). No significant main effect of List *[F(2,58)=2.83, MSe=.04, p=.07; η_p^2= .09]* nor list X response interaction *[F(2,58)=2.71, MSe=.04, p=.07; η_p^2= .08*] were found.

Please insert table 3 about here

Recall during the added phase (Phase 3) and confidence. The proportion of critical lures recalled during the added phase was computed for each participant across all lists (see Table 2). A one-way ANOVA (List type: neutral vs. negative vs. positive) with repeated measures was carried out on theses proportions and showed that the proportion of critical lures recalled during the added phase was higher for neutral lists than for both positive and negative lists *[F(2,58)=3.85, MSe=.04]*. This suggests that monitoring of the critical lures elicited by neutral lists was easier compared to critical lures from both kinds of emotional lists. The same analysis was carried out on the mean confidence ratings assigned to critical lures recalled during the added phase, and showed that the confidence ratings assigned to critical lures recalled during the added phase was similar *[F<1]* for neutral (M=3.57, SD= 1.35), negative (M=3.33, SD= 1.46) and positive lists (M=3.92, SD=1.29). The occurrence of cryptomnestic errors (i.e., the reporting of a studied item as "non studied" in the added phase; e.g., Brown & Murphy, 1989) was very infrequent (less than 2%) and was not submitted to analysis. Finally, the proportion of activated critical lures (i.e., critical lures recalled during the memory test plus critical lures produced during the added phase, see Table 2) did not differ between the lists *[F<1]*.

Overall, these data suggest that emotional and neutral lists had the same probability of eliciting critical lures, but that participants had more difficulties in accurately monitoring the source of their memories when presented with both positive and negative lists compared to neutral lists. One might argue that the results from the added phase are not a pure memory monitoring measure as it involves re-presenting the recalled items. That is, representing the semantic associates may have reactivated the critical lures in the participant's mind which, in turn, would have overestimated the monitoring measure through unconscious activation processes (e.g., Seamon, Lee, Toner,

Wheeler, Goodkind, & Birch, 2002). In addition, it is a retrospective judgment that, like the others, could be subject to distortion. Although possible, we do not think that these played a major role in our results as, in previous studies (Dehon, 2006; Dehon & Brédart, 2004), we have found that results in the added phase are influenced by manipulations that are known to specifically affect monitoring processes (e.g., aging, divided attention). In addition, because associates in emotional lists share both semantic and affective similarities, one might have expected that representing them would reactivate the critical lures more often than neutral ones. In contrast to this suggestion, we found no differences between the rates of activation of emotional and neutral lists. In addition, we have used this procedure with older participants that are known to have problems with remembering. Nevertheless, the rates of activation in our groups of older adults were quite high and similar to that of their younger counterparts (Dehon & Brédart, 2004; Dehon, 2006).

Finally, the examination of the confidence ratings did not discriminate the false recalls elicited by neutral versus emotional lists. However, illusory recollection as measured by the proportion of "Remember" responses (e.g., Tulving, 1985) assigned to falsely recalled critical lures was greater for negative lists than for the other lists, which is in agreement with the results from our first experiment.

GENERAL DISCUSSION

The aim of this study was to examine the influence of emotion on the production of false memories. More specifically, we wanted to determine, following the Paradoxical Negative Emotion Hypothesis (e.g., Porter et al., 2008), whether the effect would be more important for negative compared to positive and neutral materials. In two experiments, we presented participants with neutral, negative and positive DRM lists that were matched for word length, frequency, arousal, imagery, associative strength, and

identifiability of the critical lure. Participants were asked to complete a recognition (Experiment 1) or a recall test (Experiment 2) and were asked to provide confidence ratings and subjective judgements of remembering and knowing.

Although the Paradoxical Negative Emotion hypothesis predicts that negative information is more likely to be remembered than both positive and neutral information, the results of both experiments consistently showed that emotion and the specific valence used did not influence accurate memory either quantitatively or qualitatively. That is, valence did not affect the rates of correct recognition or correct recall and did not affect the recollective experience associated with correct performance, either when measured with confidence ratings or with "Remember" judgements.

Although this might seem inconsistent with the PNE hypothesis at first glance, some have argued that the difference between emotional and neutral words in memory might be due to differences in semantic cohesiveness between both kinds of material (e.g., Maratos, Allan & Rugg, 2000; Phelps, LaBaar, Anderson, O'Connor, Fulbright, & Spencer, 1998; Talmi & Moscovitch, 2004; Talmi et al., 2007). According to this proposal, emotional words influence memory largely because, unlike neutral words, they tend to belong to categories that are semantically "cohesive" (i.e., categories in which the constituent items share strong inter-item associations). A higher degree of semantic relatedness between items would make them better organized in memory, leading to the formation of many cues that can be used for item recall. However, in the current experiments, we matched our lists on associative strength (i.e., a measure related to inter-item associations). Thus, semantic cohesiveness could be considered as comparable between emotional and neutral lists. Accordingly, we found no improvements in accurate recognition and no influence of valence on phenomenological experience (as measured with confidence ratings and "Remember" judgements). These results support previous

findings suggesting that the advantage of emotional material in both recognition and recall tests on neutral material disappear when semantic cohesiveness is controlled (i.e., Talmi et al., 2004; 2007). In addition, compared to semantic DRM lists, memory for public events may be qualitatively different, being, for instance, more complex or more arousing events than word lists. This difference in levels of arousal between our stimuli and other kind of stimuli used to induce false memories will be discussed further in the end of the discussion.

In contrast, although we obtained substantial rates of false recognition or false recall of critical lures for each kind of material, positive and negative lists induced higher rates of false recognition and false recall than neutral lists. This effect does not seem to stem from enhancement of memory per se, as emotion had little impact on veridical performance and on recollection associated with correct performance. In addition, results from the recognition test showed that participants did not make more old responses to emotional than to non emotional distractor items (i.e., distractors other than critical lures), suggesting that it was not simply due to the use of more liberal criteria of response for emotional versus non emotional items.

It is not entirely clear why there were more false recognition and recall of critical lures following the study of emotional DRM lists than neutral ones. One explanation might be that although shared semantic features of studied items can facilitate the creation of inter-item associations in memory making later recall or recognition more likely, the probability of making context confusion would also be higher in these conditions (e.g., Henkel & Franklin, 1998). Because semantic cohesiveness between emotional and non emotional lists could be considered as similar in our experiments, we should have observed similar rates of false recognition of the critical lures in emotional and neutral lists, which, however, was not the case. Alternatively, both semantic and

emotional similarities present in emotional lists might have made the critical lures less distinctive compared with critical lures from neutral lists (e.g., Huang et al., 2006; Pesta et al., 2001). Consequently, participants had more difficulties in efficiently monitoring critical lures at retrieval. As a support for this proposal, results from experiment 2 (added phase) showed that emotional lists were not more likely to increase the activation of the critical lures. Indeed, the estimates of activation were not different between the emotional and neutral lists. Rather, emotional lists significantly reduced the estimates of successful monitoring of the critical lures compared to neutral lists.

Although consistent with the activation-monitoring account of DRM false memories (e.g., Gallo & Roediger, 2002; McDermott & Watson, 2001; Roediger, Watson, McDermott & Gallo, 2001), the overall results also fit with the fuzzy-trace theory (e.g., Brainerd & Reyna, 2002; Brainerd et al., 2001). Following this theory, memory judgements are based on verbatim or gist traces that are encoded in parallel at study. Verbatim traces capture the surface details of physical stimuli, and gist traces represent the meaning of the stimuli but lack perceptual details. Recall of studied items is based on a dual retrieval mechanism. One mechanism involves direct access to verbatim traces of list items and mainly supports veridical recall. A second mechanism reconstructs the items by processing the gist representation and is also responsible for false recall (e.g., Brainerd & Reyna, 2002; Brainerd et al., 2001). More specifically, critical lures are identified as part of the presented lists due to the attributes they share in common with the items on their corresponding study list. In contrast, verbatim representations can be used to edit out critical lure items during retrieval. Indeed, false-but-cue-consistent information may come to mind during retrieval and cue verbatim details of the corresponding presented items, which may counter the familiarity associated with false-but-cue-consistent information (e.g., Brainerd et al., 2001). Hence,

both theories imply that the critical lure will be likely to seem familiar due either to activation or reliance on gist traces (i.e., traces that support the general semantic theme). In addition, both explanations rely on the availability of item-specific information for the successful editing of memories.

In the context of the fuzzy-trace theory, some data suggest that emotion enhances the ability to remember the gist of scenes and stories but can reduce memory for specific details (e.g., Adolphs, Denburg & Tranel, 2001; Adolphs, Tranel & Buchanan, 2005). If the gist representation of emotional lists is more robust than that of non-emotional lists in the DRM because they shared both semantic and valence similarities, participants may be more likely to experience familiarity on the recognition test for emotional than non-emotional lures. However, because veridical performance (which can also be supported by gist processing) and false alarms to distractors (that are essentially supported by gist processing) were not increased for emotional items in our data, this explanation seems problematic.

In studies using Remember-Know procedures, it has usually been observed that negative stimuli tend to be associated with "Remember" responses, whereas positive stimuli tended to be associated with "Know" responses (e.g., Bless & Schwartz, 1999; Dewhurst & Parry, 2000; Ochsner, 2000 but see D'argembeau, Comblain & Van der Linden, 2004). Although we did not observe this pattern for correct performance, it was found for false remembering. Indeed, while making false recognition and false recall of the critical lures more likely, the specific valence of the lists seemed to have a particular effect on the recollective experience associated with these false memories. That is, negative false memories elicited more "Remember" responses (see also, Pesta et al., 2001) compared to neutral and positive false memories. One account of these illusory recollections is that a critical lure would seem familiar to the participants because of a

spreading of activation in the semantic network due to the presentation of the lists words (e.g., Gallo & Roediger, 2003) or because it shares strong similarities with the word lists (Lampinen et al., 2005; Brainerd et al., 2002). This familiarity would then induce a search for corroborating details in memory (that the subject presumed was associated with the critical lure) in order to explain this feeling of familiarity. During this search, characteristics associated with the list words would be associated with the critical lure due to different mechanisms such as inference (e.g., Mather et al., 1997) or content borrowing (e.g., Lampinen et al., 2005).

Hence, in the context of emotional lists, critical lures may have been activated through the presentation of their associates or because they shared similarities, resulting in a facilitated processing of emotional relative to non emotional ones. This facilitation in processing may lead to enhanced fluency, which produces a sense of familiarity in subjects (Whittlesea, 1993; Whittlesea & Williams, 2000). Consequently, participants may start searching for recollective details to account for this high feeling of familiarity, thereby increasing illusory recollection. One puzzling finding, however, is that negative false memories were more associated with “Remember” responses than positive false memories. However, if increased similarity is responsible for the higher rates of false memories and its associated illusory recollection, it seems surprising that both kinds of lists that shared the highest similarities lead to similar rates of false recall and false recognition but that they did not drive fluency attributions the same way. Although we have no ready explanation for why negative information was more accompanied with “Remember” judgements, one tentative explanation would be that, due to their adaptive importance (Lazarus, 1991; Porter et al., 2008), non-presented negative information that is highly familiar may induce a greater likelihood to start a search for details in memory to corroborate this familiarity compared to positive and neutral information. This, in turn,

would make them more likely to produce illusory recollection. Indeed, because these events are typically highly memorable, we remember them well, so why would we experience this high feeling of familiarity for a negative event if this is something that has never occurred? To resolve this conflict, individuals may be more likely to retrieve a likely explanation. Moreover, in this condition of high similarity between studied items and unstudied critical lures, binding of contextual characteristics (such as the location of the word in the list, or associated thoughts or feelings elicited by its presentation) is less likely to be correct and context confusions are even more likely.

An alternative account of illusory recollection is that participants may consciously generate the critical lure (e.g., "black") that has never been presented during study in response to the presentation of the list words (e.g., "white"; see Implicit Associative Response, IAR, Underwood, 1965). The generated critical lure would then possess its own characteristics (the moment of occurrence of the generation, a personal association, an emotional reaction…). The participants may subsequently remember these generations (Brédart, 2000; Dehon, 2006; Dehon & Brédart, 2004; Dewhurst, 2001) and recollect their associated characteristics, which would result in illusory recollections. Results from the second experiment suggest that individuals sometimes consciously thought of critical lures but were able to correctly monitor them at retrieval, although monitoring was more difficult for emotional than non emotional ones (see results from the added phase in Experiment 2). One might then suggest that, in some cases, participants may have thought of critical lures at study in response to the presentation of the list words. Subsequently, they may have remembered these generations and recollected their associated characteristics, which would have resulted in illusory recollections. It would be interesting in a future study to use, for instance, think-out-loud protocols (see Lampinen et al., 2005) to determine the best account of the origin of illusory recollection

for negative false memories. That is, to examine whether participants overtly generate emotional critical lures as Implicit Associative Responses (Underwood, 1965) in response to the presentation of the associates and whether these generations occur more often for emotional than neutral lists.

It would also be interesting to examine what "Remember" responses precisely refer to. Indeed, think-out loud protocols may allow specifying the kind of information that accompanies "Remember" judgements for neutral and emotional items. That is, in some cases, "Remember" responses may refer to rich or complex details associated with the presentation of the item (e.g., Lampinen et al., 2005). It may be possible that, compared to neutral critical lures, "Remember" responses for emotional critical lures refer to indistinctive emotional or associative reactions following the presentation of associates, rather than to rich illusory recollections.

Note that, during the redaction of this article, we were aware of recent results from Brainerd and colleagues (Brainerd, Stein, Silveira, Rohenkol & Reyna, 2008). In their studies they presented positive, neutral and negative lists and conjoint recognition methodology (Brainerd et al., 2001; Lampinen et al., 2005). Although they found that negative lists were more likely to induce false recognition of the critical lures than other lists, their results contrast with the current experiments as they found that positive lists elicit less false recognition than neutral lists. In addition, in their results, their measure of illusory (i.e., "Phantom") recollection was more associated with positive lists than with negative lists. However, since they used a different procedure to estimate illusory recollection than "Remember –Know" judgements and since they did not match their lists on concreteness, the differences between results in their study and the present study may be due to differences in methodology.

Finally, one limit of our study is that although the emotional words used clearly had an affective meaning for individuals, they did not elicit strong emotional arousal (see material characteristics). This is in contrast with other kinds of stimuli (except "taboo words"), where the mechanisms that influence memory in these cases may be different (Kensinger & Corkin, 2004; Kensinger & Schacter, 2005; Phelps et al., 1998; see also Corson & Verrier, 2007). However, arousal alone does not seem to be the sole factor that increases vividness. Indeed, studies have shown that items that evoke a change in valence but not in arousal can also be remembered in detail (e.g., Kensinger & Corkin, 2003; Ochsner, 2000). In addition, other studies (not using the DRM procedure) have found increased source-monitoring errors with high arousing items (e.g., Cook et al., 2007). Hence, it would be interesting for further studies to examine the influence of emotion on DRM false memories using, for instance, highly arousing pictures or taboo words as stimuli.

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Table 1

Mean proportions of old responses (top) to studied items, critical lures, and distractors matched to the studied items (FAs) or to the critical lures (FAcl) as a function of the list type. Mean confidence ratings (middle), proportion of "Remember" responses and proportions of "Know" responses (bottom) assigned to studied items and critical lures as a function of list type. Standard deviations are presented in brackets.

	List type		
Old responses	**Neutral**	**Negative**	**Positive**
Studied	.54 (.08)	.57 (.03)	.52 (.05)
Critical lures	.42 (.06)	.60 (.11)	.59 (.08)
FAs	.03 (.01)	.04 (.01)	.05 (.04)
FAcl	.03 (.02)	.03 (.01)	.04 (.03)
Confidence ratings	**Neutral**	**Negative**	**Positive**
Studied	4.31 (0.12)	4.02 (0.26)	4.19 (0.18)
Critical lures	3.86 (0.12)	3.68 (0.31)	3.54 (0.34)
Remember responses	**Neutral**	**Negative**	**Positive**
Studied	.36 (.19)	.34 (.15)	.33 (.13)
Critical lures	.28 (.33)	.41 (.32)	.27 (.20)
Known responses	**Neutral**	**Negative**	**Positive**
Studied	.18 (.14)	.23 (.11)	.19 (.12)
Critical lures	.14 (.19)	.19 (.22)	.32 (.25)

Table 2

Mean proportions of studied items, critical lures, intrusions other than the critical lures recalled during the recall phase, measure of source monitoring and activation rate for positive, negative and neutral DRM lists. Standard deviations are presented in brackets.

	List type		
	Neutral	**Negative**	**Positive**
Studied	.58 (.13)	.54 (.12)	.55 (.12)
Critical lures	.19 (.18)	.37 (.31)	.39 (.30)
Other intrusions	.02 (.02)	.03 (.03)	.03 (.02)
Source monitoring measure	.35 (.30)	.22 (.26)	.23 (.29)
Activation rate	.54	.60	.62

Note: Source monitoring measure = Critical lures recalled during the added phase, Activation rate = proportion of critical lures recalled during the recall phase (critical lures) + proportion of critical lures recalled during the added phase (source monitoring measure).

Table 3

Mean confidence ratings (top), proportion of "Remember" responses (middle) and proportion of "Know" responses (bottom) assigned to studied items and critical lures for neutral, negative and positive DRM lists. Standard deviations are presented in brackets.

		List type	
Confidence ratings	**Neutral**	**Negative**	**Positive**
Studied	4.68 (0.29)	4.56 (0.37)	4.56 (0.38)
Critical lures	3.39 (1.45)	3.46 (1.40)	3.43 (1.48)
Remember responses	**Neutral**	**Negative**	**Positive**
Studied	.36 (.15)	.32 (.12)	.32 (.14)
Critical lures	.09 (.12)	.27 (.23)	.18 (.20)
Know responses	**Neutral**	**Negative**	**Positive**
Studied	.22 (.14)	.22 (.14)	.24 (.19)
Critical lures	.10 (.12)	.11 (.12)	.21 (.20)

APPENDIX

Neutral lists

Temps (time): durée (duration), seconde (second), minute, montre (watch), année (year), période (period), jour (day), mois (month), siècle (century), moment, date, instant.

Odeur (odor): parfum (perfume), senteur (scent), effluve (effluvia), nez (nose), arôme (aroma), puanteur (stink), fragrance, fumet (bouquet), émanation (emanation), relent (stench), fleurs (flowers), rose.

Dessin (drawing) : croquis (sketch), esquisse (outline), tracé (layout), crayon (pencil), caricature, illustration, trait, image, figure, ébauche (sketch), portrait, fusain (charcoal).

Musique (music) : instrument, concert, orchestre (orchestra), symphonie (symphony), note, mélodie (melody), piano, son (sound), classique (classical), chanter (to sing), rythme (rythm), radio.

Negative lists

Guerre (war) : bombardement (bombarding), soldat (soldier), bataille (battle), armes (weapons), tank, combat (fight), affrontement (confrontation), morts (deaths), conflits (conflict), grenade, explosion, haine (hatred).

Esclave (slave) : serviteur (servant), enchaîné (enslaved), soumis (submissive), nègre (negro), exploité (abused), assujetti (bound), prisonnier (prisoner), captif (captive), dominé (dominated), maltraité (mistreated), contraint (constrained), obligé (compelled).

Tristesse (sadness) : peine (sorrow), chagrin (grief), larmes (tears), désespoir (despair), pleurs (sor), deuil (bereavement/mourning), mélancolie (dolefulness), malheur (ordeal), sanglot (sobbing), dépression, spleen, désolation (desolation).

Peur (fear) : crainte (alarm), frayeur (fright), phobie (phobia), terreur (terror), effroi (dread), épouvante (dismay), frousse (fright), angoisse (anguish), panique (panic), trac (nerves), appréhension (apprehension), anxiété (anxiety).

Positive lists

Force (strength) **:** herculéenne (Herculean), puissance (force), musculature, robustesse (robustness), énergie (energy), vigueur (vigorousness), tonus (drive), solidité (solidity), endurance, résistance (resistance), virilité (virility), pouvoir (power).

Courage : bravoure (braveness), cran (daring), témérité (foolhardiness), vaillance (valiance), hardiesse (boldness), audace (audacity), ténacité (tenacity), volonté (will), détermination (determination), ardeur (ardour), assurance, opiniâtreté (persistency).

Vacances (holidays) : congé (vacation), voyage (journey), détente (relaxation), plage (beach), soleil (sun), villégiature (holiday spot), délassement (diversion), relâche (release), tranquillité (rest), décontraction (coolness), pause (break), sérénité (serenity).

Chance (luck) : veine (luck), Lotto (lottery), aubaine (windfall), hasard (chance), fortune, coïncidence (coincidence), opportunité (opportunity), succès (success), réussite (success), occasion, argent (money), prospérité (prosperity).