The Effect of Negative Mood on False Recall and Recognition

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The present study attempted to determine whether negative mood state reduces the occurrence of false recall and false recognition of non-presented critical words using the Deese-Roediger-McDermott (DRM) paradigm. The logic was that if negative mood encourages participants to engage in systematic elaboration of presented material, participants would encode more distinctive information leading to better discrimination between list words and non-presented critical lures and consequently produce fewer false memories. In Experiment 1, ninety participants studied a long list of semantically-related negatively-toned words. In half the participants, negative mood was experimentally induced through the presentation of appropriate classical music. The remaining participants were not presented with music, and served as a control neutral mood group. The results demonstrated that participants with negative mood recalled and recognized fewer critical lures than did the participants with neutral mood. In Experiment 2 and 3, we attempted to replicate and extend these results by including a positive mood group, with the hypothesis that individuals in the positive mood group would engage in less elaborative processing and therefore show more false memories. In the second and third experiments; however, we failed to detect mood effects on false memories. Some methodological reasons are discussed.

Recently there has been considerable interest in the idea of false memories, described as memories for events that never actually occurred. One recently used paradigm for false memory research was developed by Roediger and McDermott (1995), based on earlier research by Deese (1959), which is now known as the Deese-Roediger-McDermott (DRM) paradigm. In this DRM paradigm, participants are asked to learn lists of words that are all semantically associated with the same critical non-presented word. Each list is composed of 15 words related to one critical non-presented word. An example of a list for the critical non-presented word '*sleep*' is : *bed, rest, awake, tired, dream, wake, night, blanket, doze, slumber, snore, pillow, peace, yawn*, and *drowsy*. Their experiments revealed remarkable levels of both false recall and false recognition of critical non-presented words. Using the DRM paradigm, numerous studies have focused on the boundary conditions sufficient for producing false memories (for reviews, see Roediger, Balota, & Watson, 2001 ; Roediger, McDermott, & Goff, 1997 ; Roediger, McDermott, & Robinson, 1998).

However, when we focus attention on the theoretical factors involved in the creation of false memories, the theoretical implications are not so straightforward. One widely accepted theory, the automatic activation-based hypothesis, posits that the critical non-presented word becomes activated as an implicit associate response to its associates in the study list (Roediger et al., 2001 ; Underwood, 1965, 1969). For example, when the word *bed* is presented in the study list, the corresponding node is activated. This activation of the node then automatically spreads throughout the memory structures to which it is associatively connected (e. g., Anderson, 1983 ; Collins & Loftus, 1975). Once the critical non-presented associate *sleep* has been activated by the spreading of activation during the initial study session, participants later falsely recall or recognize the word because of a failure to monitor correctly the source of the word's activation (Johnson & Raye, 1981 ; Johnson, Hashtroudi, & Lindsay, 1993). Given that the strength of spreading activation is a function of the total number of activated list words, a larger number of associate words in the list should increase the probability of false remembering. This prediction is supported by several investigators (e. g., Robinson & Roediger, 1997).

Others have argued that false memories are caused by the lack of distinctive information at encoding (Israel & Schacter, 1997 ; Schacter, Israel, & Racine, 1999). According to their proposal, when participants are provided with salient visual information (e. g., pictures) at study, they are expected to be able to retrieve this distinctive information at test. Such distinctive information would enhance the discriminability between the words that were actually presented and those that were not, resulting in more accurate source monitoring and fewer false memories. In accordance with the distinctive information-based hypothesis, Israel and Schacter (1997) observed a reduction in false remembering when participants were presented with pictures relevant only to the words being studied. If the distinctive information is obtained through encoding manipulations such as levels of processing and elaboration (Cermak & Craik, 1979 ; Craik & Lockhart, 1972 ; Craik & Tulving, 1975), we would expect to find that such semantic processing reduces false remembering. Several researchers have demonstrated that semantic processing (e. g., the judgment of pleasantness of each item) decreases the probability of false remembering (e. g., Smith & Hunt, 1998). The reduction in false memories associated with the use of the semantic orienting task may be due to more extensive processing of each list word, thereby resulting in more distinctive information.

The core difference between the automatic activation-based hypothesis and the distinctive information-based hypothesis is the emphasis on automaticity. According to the automatic activation-based hypothesis, the formation of the memory trace is understood to be the consequence of automatic activation that is difficult to control intentionally. However, in the distinctive information-based hypothesis, the encoding of the distinctive information is assumed to be performed by deliberate extensive processing. Although we agree with the proposition that both hypotheses are needed to explain the false memory phenomenon comprehensively (Benjamin, 2001, McDermott & Watson, 2001), we further investigate the automatic activation-based vs. distinctive information-based hypotheses of false memories in the present experiments. Specifically, we wanted to know whether negative mood reduces the false recall and false recognition rates, which we assessed using a list of semantically-related negatively-toned words.

Previous research has demonstrated that participants in whom negative mood was experimentally induced recalled and recognized more negatively-toned words than did participants in whom neutral and positive moods were induced (e. g., Bower, Gilligan, & Monteiro, 1981). Bower (1981, 1992; Bower & Cohen, 1982) modified the automatic activation-based hypothesis to propose that these mood-congruent effects are caused by automatic spreading activation within an associative network. One key aspect of the theory posits that different emotions can be represented by different nodes in the associative network. When one emotion node is activated, the activation spreads automatically throughout the memory network structure. Thus, the negatively-toned words accrue from activation and spread to it via the activated negative emotion nodes. This accrued activation makes the negatively-toned words accessible in long-term memory and increases the likelihood that they will be better remembered than those encoded in neutral mood. Therefore, in keeping with the automatic activation-based hypothesis, we predicted that the probability of false memories would increase with negative mood, as the non-presented negatively-toned associates would be more activated by the total amount of spreading activation present during negative mood than during neutral mood.

In contrast, in the domain of social psychology, several researchers suggest that negative mood (i. e., sad mood) is associated with systematic elaboration of information, whereas positive mood (i. e., happy mood) is associated with heuristic processing strategies (Bless, 2000; Bless & Schwarz, 1999; Clore, Schwartz, & Conway, 1994; Fiedler, 1990, 1991, 2001). Given that systematic elaboration under negative mood produces distinctive information (Bless, Clore, Schwarz, Golisano, Rabe, & Woelk, 1996), negative mood should reduce false remembering compared to neutral and positive moods, as predicted by the distinctive information-based hypothesis. Note that under negative mood the more distinctive the list words are, the more they are remembered compared to neutral moods.

In sum, the automatic activation-based hypothesis predicts better memory performance for list words and more false memories for the participants induced with a negative mood, whereas the distinctive information-based hypothesis predicts better memory performance for the list words and fewer false memories in participants induced with a negative mood. It thus stands to reason that if participants remember fewer non-presented critical words when induced with negative mood, then the automatic activation-based hypothesis does not provide an adequate theoretical explanation for the false memory phenomenon. In contrast, a larger number of false memories of the non-presented words in negative mood would provide support for the automatic activation-based hypothesis.

Experiment 1

In the present experiment, we used a continuous music mood induction procedure to facilitate the maintenance of mood states (Clark, 1983 ; Gerrards-Hesse, Spies, & Hesse, 1994). At the beginning of the experiment, all participants filled out a pre-experimental mood questionnaire. Then, participants in the sad mood experimental group heard the appropriate classical music, whereas those in the neutral mood heard no music at all. After the initial mood induction period, all participants filled out a second mood questionnaire, then performed the memory task.

Method

Participants. The participants were 90 undergraduate students (34 male and 56 female) enrolled in an introductory psychology course at Kinki Welfare University who received course credit for participating in the experiment. Their ages ranged from 18 to 22 years. Participants were randomly assigned to either the neutral or sad mood group. Each group was tested as a unit in a classroom setting. None had participated in any related memory research.

Design. A 2 (mood state: neutral and sad) X 2 (item type: list item and critical lure) mixed-factorial design was used, with mood states manipulated across participants and item type manipulated within participants.

Materials. The five 15-item negatively-toned sublists used in the present experiment were the "order", "election", "pain", "war" and "suicide" lists taken from Takahashi (2001) on the basis of their producing relatively high levels of the critical items. These five critical non-presented words were originally selected using the norms by Imae (1975) and were listed as negative words. An example of a list for the critical non-presented word'*war*' is: *tank, atomic bomb, fires, nuclear weapon, disturbances, fight, cannon, peace, bomb, Hiroshima, gun, conflict, destruction, battle,* and *renunciation.* The study sublists are presented in the appendix. The lists were ordered in such a manner that the strongest associates occurred earlier in each list, followed by the weaker associates. In addition, the sublists were blocked so that all of the items from each sublist were followed immediately by all of the items from the next sublist, until all five sublists were presented. During the study phase participants were presented with a list of 75 words composed of 5 sublists of 15 words each, plus an additional five primacy and five recency buffer words to eliminate any primacy and recency effects on the memory of the five sublists. The primacy and recency items were unrelated and were taken from lists other than the target sublists of the present study, also selected from Takahashi (2001). The primacy and recency buffers were the same for all conditions and the data from these items were not scored. The list was presented in the same order to all participants. Each item was presented individually on a large television screen using large black letters (157-point font) on a white background, at the rate of two seconds per item.

Similar to other studies of false memories (e. g., Gall, Roberts, & Seamon, 1997; Roediger & McDermott, 1995; Seamon, Luo, Schlegel, Greene, & Goldenberg, 2000), recognition memory was tested using only a portion of the studied stimuli. The 40-item recognition test included 15 studied and 25 nonstudied items. The 15 studied items were obtained by selecting 3 items (those in serial positions 1, 8, and 10) from each of the five sublists. The lures, or nonstudied items, on the recognition test were the 5 critical words from the 5 sublists and 20 items from the 5 positive-toned critical words and 15 items from the 5 nonstudied positive-toned lists (again, from serial positions 1, 8, and 10) selected from Takahashi (2001). The 40 items were divided into five arbitrary subsets of 8 words and a 5-page booklet was constructed with eight words printed on each page. The pages within each booklet were combined in a different random order for each participant.

Music. In the present experiment, the music used to induce negative (i.e., sad) mood was "Adagio for Strings and Organ" by Albinoni, with a duration of approximately 12 min. The music was selected on the basis of norms developed by Taniguchi (1999). He subjected to analyze the ratings of the 16 emotions items from the Japanese Multiple Mood Scale (Terasaki, Koga, & Kishimoto, 1991), items rated by approximately 50 college female students who were exposed to the sad and happy music mood-induction procedures. These selections have been used effectively in previous research (e. g., Taniguchi, 1991). The music was recorded repetitively on audiotape. The music was presented on a portable tape player, with the volume adjusted individually to a comfortable hearing level for each participant.

Mood Questionnaire. We used the Japanese General Affect Scale (Ogawa, Monchi, Kikuya, & Suzuki, 2000) to quantify current mood states and the success of the experimental mood manipulations. On this questionnaire, participants are asked to rate each of 24 emotional adjectives on a four-point scale according to their current mood, where 1 corresponds to "*definitely do not feel*", 2 corresponds to "*do not feel*", 3 corresponds to "*feel somewhat*", and 4 equals "*definitely do feel*". The scale has three 8-item subscales: positive affect, negative affect, and calmness. We used only the positive affect subscale (lively, pleasantly, full, cheerful, pleasant, vigorous, smooth, and motivated) because the negative affect subscale (unsettled, afraid, confused, frightened, restless, nervous, surprised, and throb) and calmness subscale (leisurely, relaxed, calm, peaceful, easy, at ease, composed, and tranquil) seemed inappropriate for assessing sad mood state in the present experiment.

Procedure. The participants randomized to the sad mood state group were told that the purpose of the experiment was to study the influence of background music on word learning. In contrast, participants in the neutral mood state group were told that the study was investigating the influence of a relaxed mood on word learning. None of the participants were informed about the associative relatedness of the lists. First, both groups were asked to complete the Japanese General Affect Scale (Ogawa et al., 2000), to determine pre-experimental mood states. Then, participants in the sad mood group listened to negative music for three minutes, while participants in the neutral mood group did not listen to music. Members of both groups then completed the Japanese General Affect Scale a second time to verify the success of the mood manipulation. The sad mood group continued to hear the emotional music until the memory test was performed in order to facilitate the maintenance of the mood states.

In the study session, participants were told to remember the long list of words presented on the large television screen. Following the list presentation, all participants were asked to recall as many words as possible in any order, writing down only the words that they were sure they had seen. They were given 5 min for the recall test. In the test phase, neither group listened to music.

Immediately following the free recall test, an unexpected recognition test was administered. Participants were told that they would be presented with words in a test booklet, and they were to rate each word as to how confident they were that it was present on the to-be-remembered list. The 6-point rating scale included the following ratings: 6 = *entirely confident that the item is old* (or previously studied), 5 = *reasonably confident that the item is old*, 4 = *somewhat confident that the item is old*, 3 = *somewhat confident that the item is new*, 2 = *reasonably confident the item is new*, and 1 = *entirely confident that the item is new*. Participants completed the recognition test at their own pace, which typically took less than 3 min. After all the participants finished, they were debriefed.

Results

Mood induction. Table 1 presents the mean of the sums of the positive affect subscale items for both the neutral and sad mood groups. Inspection of the cell means for the positive affect subscale revealed that on the second mood rating, participants' ratings in both the neutral and sad groups decreased (i.e. became sadder) relative to their ratings at the beginning of the experiment. A 2 (mood state: neutral and sad) X 2 (measurement occasion: before and after) analysis of variance (ANOVA) was conducted on the sum of the positive affect subscale items. Throughout this article, an alpha level of . 05 was adopted for statistical significance for all analyses unless otherwise noted. Results revealed a significant main effect of measurement occasion, F (1, 88) = 22. 83, MSE = 7. 11, although no other effects reached statistical significance.

To further examine the effects of mood induction, similar 2 (mood state) X 2 (measurement occasion) ANOVAs were conducted on each adjective. The analyses showed that the main effect of measurement occasion was significant for the adjectives "Lively", F (1, 88) = 24. 34, MSE = 0. 19, for "Pleasantly", F (1, 88) = 24. 21, MSE = 0. 37, for "Cheerful", F (1, 88) = 5. 31, MSE = 0. 34, for "Pleasant", F (1, 88) = 5. 80, MSE = 0. 25, for "Vigorous", F (1, 88) = 29. 47, MSE = 0. 32, and for "Motivated", F (1, 88) = 43. 84, MSE = 0. 26, respectively. There were no significant main effects of mood state for any adjectives. However, for the adjective "Lively", there was a significant interaction between mood state and measurement occasion, F (1, 88) = 4. 89, MSE = 0. 19. A Tukey Honest Significant Difference test revealed that the sad group showed lower "Lively" scores than the neutral group after mood induction, while there was no significant difference between the neutral and

Table 1 ***Means of positive mood adjectives scores before and after induction for mood manipulations in Experiment 1.***

	Mood adjectives								
	Lively	Pleasantly	Full	Cheerful	Pleasant	Vigor	Smooth	Motivated	SUM
Before									
Neutral	0. 62	0. 96	0. 53	0. 82	0. 67	0. 89	0. 87	1. 00	6. 20
	(0. 78)	(0. 74)	(0. 66)	(0. 78)	(0. 77)	(0. 86)	(0. 89)	(0. 83)	(4. 71)
Sad	0. 76	1. 11	0. 87	0. 62	0. 58	0. 89	0. 82	1. 04	6. 69
	(0. 68)	(0. 96)	(0. 89)	(0. 75)	(0. 69)	(0. 75)	(0. 68)	(0. 77)	(4. 27)
After									
Neutral	0. 44	0. 64	0. 73	0. 53	0. 49	0. 51	0. 93	0. 62	4. 91
	(0. 59)	(0. 71)	(0. 78)	(0. 66)	(0. 69)	(0. 63)	(0. 96)	(0. 75)	(4. 13)
Sad	0. 29	0. 53	0. 84	0. 51	0. 40	0. 36	0. 82	0. 42	4. 18
	(0. 51)	(0. 55)	(0. 93)	(0. 66)	(0. 58)	(0. 53)	(0. 86)	(0. 69)	(3. 73)

Note. Standard deviations are in parentheses.

sad groups before mood induction. That is, the music mood induction in the present experiment was successful, although not particularly effective.

Recall. Table 2 presents the mean proportion of list items and critical lures recalled for both the neutral and sad mood groups. As there were large differences in standard deviations between the number of list items and critical lures recalled, all analyses were carried out using an arcsine transformation of these proportions. A 2 (mood state : neutral and sad) X 2 (item type : list item and critical lure) ANOVA was conducted on these data. Results revealed a main effect of item type, F (1, 88) =28. 45, MSE = 0. 05. There was a trend towards a main effect of mood state, F (1, 88) =2. 95, MSE = 0. 05, p <. 10, although there was no significant interaction between mood state and item type. Thus, for both list items and critical lures, the sad mood group produced fewer items than the neutral mood group. These results of critical lures are consistent with the distinctiveness information-based hypothesis. In contrast, we observed a mood incongruent effect for list items, rather than a mood congruent effect.

Table 2 ***Proportions of list items and critical lures recalled in Experiment 1.***

Mood states	Item type	
	List	Critical
Neutral	0. 28	0. 23
	(0. 09)	(0. 23)
Sad	0. 25	0. 15
	(0. 07)	(0. 14)

Note. Standard deviations are in parentheses.

The proportions of noncritical intrusions (other than critical lures) also were calculated. Trends towards significance were evident for neutral mood (M=0. 04, SD=0. 05) and sad mood groups (M=0. 06, SD=0. 05), t (88) =1. 69, p <. 10. In contrast with the critical intrusion findings, the sad mood group tended to produce more noncritical intrusions than the neutral mood group.

Recognition. If the participants identified the list item or critical lure as *entirely confident that the item is old, reasonably confident that the item is old* *or somewhat confident that the item is old*, the response was coded as a "recognized". Table 3 presents the mean proportions of list items and critical lures recognized for both neutral and sad mood groups. As for the recall, all analyses were carried out using an arcsine transformation. A similar 2 (mood state) X 2 (item type) ANOVA was conducted on these data. Results revealed only a main effect of mood state, F (1, 88) = 4. 15, MSE = 0. 09. That is, participants in the sad mood group remembered fewer list items and critical lures than did the participants in the neutral mood group.

To further investigate the mood effects, we calculated participants' mean confidence ratings by assigning the numbers 1–3 to the three categories 1 = *somewhat confident that the item is old*, 2 = *reasonably confident the item is old*, and 3 = *entirely confident that the item is old*. For the list items, the mean confidence ratings were 2. 84 (SD = 0. 15) and 2. 77 (SD = 0. 18) for neutral and sad mood groups, respectively. Means for the critical lures were 2. 64 (SD = 0. 44) and 2. 43 (SD = 0. 56) for the neutral and sad mood groups, respectively. A similar 2 (mood state) X 2 (item type) ANOVA performed on the confidence ratings revealed main effects of mood state and item types, F (1, 88) = 5. 26, MSE = 0. 17, and F (1, 88) = 28. 73, MSE = 0. 11, respectively. However, there was no significant interaction between the two factors. Therefore, the pattern of results for the confidence measures is essentially the same as that for the proportions of list words recognized.

Table 3 ***Proportions of list items and critical lures recognized in Experiment 1.***

Mood states	Item type	
	List	Critical
Neutral	0.87	0.82
	(0.12)	(0.21)
Sad	0.83	0.76
	(0.13)	(0.21)

Note. Standard deviations are in parentheses.

If the participants identified a nonstudied word (other than a critical lure) as *entirely confident that the item is old, reasonably confident that the item is* *old*, or *somewhat confident that the item is old*, the response was coded as a "false alarm". An independent t-test was conducted on the "false alarm" rates and revealed that there was no significant difference between the neutral mood (M=0. 06, SD=0. 13) and sad mood groups (M=0. 05, SD=0. 09), although this may have been attributable to a floor effect.

Discussion

The key finding from this experiment was that negative mood reduced the false recall and false recognition rates of critical non-presented lures. This pattern of results is consistent with the prediction driven by the distinctive information-based hypothesis, as opposed to the automatic activation-based hypothesis. In contrast, we failed to obtain the predicted mood-congruent effect in the list words. However, robust mood congruent effects have been found in positive moods. When negative moods are considered, the effects are weaker and more inconsistent. The asymmetric influence of positive and negative moods has been reported in many studies that positive moods enhance memory of positive material, but negative emotions do not exert effects on the processing of negative material (e. g., Nasby & Yando, 1982; Taniguchi, 1991).

In the present experiment, the music mood induction was not particularly successful since participants did not reach high levels of sad mood. To reduce heterogeneity of the participants in the sad mood group, an additional analysis was performed on the data with the data points of the participants whose mood states were unaffected by the music excluded (as in Halberstadt, Niedenthal, & Kushner, 1995). Specifically, the data from participants who were in the sad group but whose sum of positive affect changed scores fell beyond 1 standard deviation toward the positive end of the scale (5 participants) were removed. However, this analysis revealed comparable results to those previously noted.

There is some evidence of a gender difference in the effects of mood on the recall of positive and negative words (Clark & Teasdale, 1985) in that the mood congruent memory effect has been found to emerge only with females. Inspection of the proportion of males to females for each group revealed a difference in proportions between the neutral mood group (13 males and 32 females) and sad mood group (21 males and 24 females). Therefore, the reduced effectiveness of the mood induction might have been attributable to the mixed-gender groups used in the present experiment.

Experiment 2

The purpose of Experiment 2 was to replicate and extend the results of Experiment 1. To assure adequate effectiveness of the mood induction (Clark & Teasdale, 1985), only females participated in the experiment. We also added a positive mood group in which participants heard the appropriate music. Previous research has suggested that participants in whom a positive mood is induced perform less systematic elaborative processing (Bless, 2000; Bless & Schwarz, 1999; Clore et al., 1994; Fiedler, 1990, 1991, 2001). If this is the case, they would therefore be expected to encode less distinctive information during learning. Accordingly, the distinctive information-based hypothesis would predict that the positive mood group would produce a larger number of false memories than the other two groups. In contrast, the automatic activation-based hypothesis would predict that the positive mood group would produce the fewest false memories among the groups, because positive mood might inhibit the spreading of activation in the negatively-toned semantic network.

Method

Participants. The participants were 99 undergraduate female students at University of the Sacred Heart. Their ages ranged from 18 to 21 years. Participants were randomly assigned to one of three mood state groups (neutral, sad, and happy), with each group consisting of 33 participants. Participants either received credit in partial fulfillment of course requirements or were paid ¥500 (approximately $5). The participants were run in groups ranging from 2 to 10 individuals. None had participated in any related memory research.

Design. A 3 (mood state: neutral, sad, and happy) X 2 (item type: list item and critical lure) mixed factorial design was used, with mood state manipulated across participants and item type manipulated within participants.

Materials and Procedure. The present experiment used the same materials used in Experiment 1, with the exception of the positive mood manipulation. In Experiment 2, the musical piece "Joy of Love" by Kreisler, with a duration of approximately 4 minutes, was used to induce positive (i. e., happy) mood. This music was also selected on the basis of norms developed by Taniguchi (1998). In the test phase, none of the groups listened to music. The procedures for the study phase and recall test were identical to those of Experiment 1. For the participant-paced recognition test, the same 40 items as in Experiment 1 were printed, one word per page, and randomly presented in a 40-page test booklet. These items were presented in a different random order for each participant.

Results

Mood induction. Table 4 presents the mean value of the sum of the positive affect subscale items for the three mood groups. A 3 (mood state : neutral, sad, and happy) X 2 (measurement occasion : before and after) ANOVA was conducted on the sum of the positive affect subscale. Results revealed no significant main effects of mood state nor measurement occasion. However, the interaction between the two factors was significant, F (1, 96) = 12. 28, MSE = 8. 46. Post hoc analysis using the Tukey Honest Significant Difference test revealed no significant difference among the three groups prior to mood induction. In contrast, the happy group (M = 9. 18) showed significantly higher scores than the neutral (M = 5. 79) and sad (M = 4. 73) groups after mood induction, while there was no significant difference between the neutral and sad groups.

To further examine the mood manipulation, similar 3 (mood state) X 2 (measurement occasion) ANOVAs were conducted on each adjective. The analyses showed that no main effects of mood state were present. There were significant main effects of occasion for the adjectives "Pleasantly", F (1, 96) = 6. 90, MSE = 0. 29, and for "Motivated", F (1, 96) = 6. 90, MSE = 0. 26. However, there also were significant interactions between mood state and measurement occasion for "Lively", F (2, 96) = 3. 19, MSE = 0. 29, for

"Pleasantly", F (2, 96) =8.35, MSE=0.29, for "Full", F (2, 96) =3.78, MSE=0.27, for "Cheerful", F (2, 96) =15.19, MSE=0.31, for "Pleasant", F (2, 96) =10.33, MSE = 0.40, for "Vigorous", F (2, 96) = 11.87, MSE = 0.32, and for "Smooth", F (2, 96) =9.28, MSE=0.31.

Post hoc analyses using the Tukey Honest Significant Difference test revealed no significant differences among the three groups for the adjectives before mood induction. However, the happy group showed significantly higher scores than the sad group following mood induction for the adjectives "Lively", "Vigorous", and "Smooth", while there were no significant differences between the happy and neutral groups. Also, the happy group had significantly higher scores than sad and neutral groups after mood induction for the adjectives "Pleasantly", "Cheerful", and "Pleasant", while there were no significant differences between the sad and neutral groups. Therefore, the music mood induction was judged to be successful in the present experiment.

Table 4 ***Means of positive mood adjectives scores before and after induction for mood manipulations in Experiment 2.***

	Mood adjectives								
	Lively	Pleasantly	Full	Cheerful	Pleasant	Vigor	Smooth	Motivated	SUM
Before									
Neutral	0.70	1.18	1.12	0.70	0.70	0.91	1.12	1.03	7.15
	(0.68)	(0.85)	(0.93)	(0.81)	(0.81)	(0.95)	(0.78)	(0.78)	(5.05)
Sad	0.58	1.12	0.70	1.03	0.67	0.97	1.13	0.94	6.73
	(0.75)	(0.82)	(0.81)	(0.81)	(0.69)	(0.81)	(0.87)	(0.83)	(5.05)
Happy	0.64	1.09	0.97	0.70	0.48	0.73	0.82	1.12	6.55
	(0.65)	(0.68)	(0.92)	(0.81)	(0.76)	(0.84)	(0.68)	(0.65)	(4.38)
After									
Neutral	0.58	0.76	0.79	0.64	0.39	0.73	1.03	0.88	5.79
	(0.61)	(0.79)	(0.70)	(0.65)	(0.61)	(0.76)	(0.81)	(0.82)	(4.29)
Sad	0.33	0.70	0.70	0.58	0.55	0.48	0.76	0.64	4.73
	(0.54)	(0.81)	(0.73)	(0.66)	(0.75)	(0.62)	(0.83)	(0.70)	(4.33)
Happy	0.85	1.33	1.12	1.34	1.12	1.18	1.30	0.97	9.18
	(0.76)	(0.60)	(0.70)	(0.75)	(0.82)	(0.77)	(0.59)	(0.64)	(3.91)

Note. Standard deviations are in parentheses.

Recall. Table 5 presents the mean proportions of list items and critical lures recalled for three mood groups. As in Experiment 1, all analyses were carried out on an arcsine transformation of those proportions. A 3 (mood state: neutral, sad, and happy) X 2 (item type: list item and critical lure) ANOVA was conducted on these data. Results revealed only a main effect of item type, F (1, 96) = 18. 40, MSE = 0. 05. Neither the main effect of mood state nor the interaction between the two factors was significant. Thus, the number of list items recalled was higher than the number of critical lures recalled for all three groups.

Table 5 ***Proportions of list items and critical lures recalled in Experiment 2.***

Mood states	Item type	
	List	Critical
Neutral	0. 29	0. 25
	(0. 08)	(0. 17)
Sad	0. 29	0. 25
	(0. 08)	(0. 17)
Happy	0. 29	0. 19
	(0. 09)	(0. 18)

Note. Standard deviations are in parentheses.

Noncritical intrusions were equivalent for all groups (M = 0. 05, SD = 0. 07 for neutral mood; M = 0. 05, SD = 0. 06 for sad mood; M = 0. 05, SD = 0. 05 for happy mood). A one-way ANOVA was performed on the intrusions and revealed that the effect of groups was not significant.

Recognition. Table 6 presents the mean proportions of list items and critical lures recognized for the three groups. A similar 3 (mood state) X 2 (item type) ANOVA was conducted on the arcsine transformation of the proportions of items recognized. Results revealed a trend towards a main effect of item type, F (1, 96) = 2. 88, MSE = 0. 06, p <. 10. However, neither the effect of mood state nor the interaction between the two factors was significant.

To further investigate the mood effects, we again calculated participants' mean confidence ratings, as in Experiment 1. For the list items, the mean confidence ratings were 2. 74 (*SD*=0. 20), 2. 78 (*SD*=0. 23), and 2. 73 (*SD*=0. 20) for the neutral, sad, and happy mood groups, respectively. Means for the critical lures were 2. 86 (*SD*=0. 21), 2. 89 (*SD*=0. 19), and 2. 87 (*SD*=0. 19) for the neutral, sad, and happy mood groups, respectively. A similar 3 (mood state) X 2 (item type) ANOVA performed on the confidence ratings revealed no significant main effects or a significant interaction between the two factors.

Table 6 ***Proportions of list items and critical lures recognized in Experiment 2.***

Mood states	Item type	
	List	Critical
Neutral	0. 85	0. 81
	(0. 11)	(0. 21)
Sad	0. 87	0. 87
	(0. 12)	(0. 16)
Happy	0. 86	0. 88
	(0. 10)	(0. 15)

Note. Standard deviations are in parentheses.

The "false alarm" rates were again equivalent for all groups (*M*=0. 07, *SD* =0. 10 for neutral mood; *M*=0. 06, *SD*=0. 09 for sad mood; *M*=0. 08, *SD*=0. 12 for happy mood). A one-way ANOVA was performed on the "false alarm" rates but revealed no main effect of group.

Discussion

In contrast to the results of Experiment 1, the present experiment revealed no significant difference in recall of critical non-presented lures between the neutral and sad mood groups. That is, we failed to replicate the results of Experiment 1. One possible explanation is that the female participants did not reach strong levels of sad mood following the mood induction manipulation. As in Experiment 1, an additional analysis was performed, with the data from those participants whose mood states were unaffected by the musical inductions of sadness and happiness excluded from the data set. However, the analysis led to the same conclusions. Perhaps, because the participants in the neutral mood group were exposed to silence until the second mood questionnaire, we may have induced weak levels of sad mood, thus contributing to our failure to obtain a clear difference between the neutral and sad groups.

We failed to show a statistically reliable effect of positive moods on recall of critical lures. In addition, for the list items, we found no mood congruent effect despite the fact that the effect is usually robust when positive moods are considered. The absence of the positive mood effect does not appear to be due to the weakness of our mood inductions since the happy group showed significantly higher positive affect scores than either the neutral or sad groups following mood induction.

One methodological consideration is that the music itself could have caused the above null mood effects. Specifically, perhaps the absence of the mood effect was because the background music in the sad and happy mood groups interfered with encoding processes during the memory task.

Experiment 3

The third experiment was very similar in methodology to Experiment 2. Participants in the sad and happy mood groups heard the appropriate emotional music for a 5 min induction period, completed the mood questionnaire, and then performed the memory task. Unlike in Experiment 2, the emotional music used to induce the mood states was not continued as background music during the memory encoding task in an effort to reduce the possibility of musical interference on the memory task. In contrast, participants in the neutral mood group, which heard no music at all, first completed the mood questionnaire and then performed the memory task. In the study phase, participants in the neutral, sad, and happy mood groups were exposed to the same word lists as those used in Experiment 2.

Method

Participants. The participants were 96 undergraduate female students at the University of the Sacred Heart. Their ages ranged from 18 to 24 years. Participants were randomly assigned to one of three mood state groups (neutral, sad, and happy) so that each group was comprised of 32 participants each. Participants either received credit in partial fulfillment of course requirements or were paid ¥500 (approximately $5). The participants were run in groups of 2 to 12 individuals.

Design, Materials, and Procedure. The present experiment used the same design, word lists, and music as those used in Experiment 2. The procedure was identical to Experiment 2, with the exception of the mood induction procedure. First, the pre-experimental mood questionnaire previously completed at the beginning of the experiment was eliminated. Second, only participants in the sad and happy mood groups heard the appropriate classical music for a 5 min induction period, completed a mood scale, and then performed the memory task. The neutral mood group, which heard no music at all, began with the mood questionnaire and then performed the memory task.

Results

Mood induction. Table 7 presents the mean scores of each mood adjective rated for each of the three groups. A one-way ANOVA was conducted on the sum of the positive affect subscale. The analysis showed that the main effect was significant, $F\ (2, 93) = 4.77$, $MSE = 22.12$. Post hoc analyses using the Tukey Honest Significant Difference test revealed that the sad group ($M = 4.28$) had significantly lower scores than the neutral ($M = 7.53$) and happy ($M = 7.31$) groups, while there was no significant difference between the neutral and happy groups.

As in Experiment 2, similar one-way ANOVAs were conducted on each adjective. The analyses showed that the main effects of mood state were significant for the adjectives "Lively", $F\ (2, 93) = 4.57$, $MSE = 0.54$, for "Pleasantly", $F\ (2, 93) = 3.61$, $MSE = 0.66$, for "Cheerful", $F\ (2, 93) = 5.78$, $MSE = 0.59$, for "Vigorous", $F\ (2, 93) = 5.62$, $MSE = 0.68$, for "Smooth", $F\ (2, 93) = 5.80$, $MSE = 0.68$, and for "Motivated", $F\ (2, 93) = 4.67$, MSE $= 0.48$. Post hoc analyses using the Tukey Honest Significant Difference test revealed that the sad groups displayed significantly lower scores than the neutral groups for "Lively", "Pleasantly", "Vigorous", and "Motivated", while there were no significant differences between the sad and happy groups nor between the happy and neutral groups. For the adjective "Cheerful", the happy and neutral groups showed significantly higher scores than the sad group, while there was no significant difference between the happy and neutral groups. For the adjective "Smoothly", the happy groups showed significantly higher scores than the neutral or sad groups, while there was no significant difference between the neutral and sad groups.

Table 7 ***Means of positive mood adjectives scores after induction for mood manipulations in Experiment 3.***

	Mood adjectives								
	Lively	Pleasantly	Full	Cheerful	Pleasant	Vigor	Smooth	Motivated	SUM
Neutral	0.81	1.19	1.00	0.91	0.63	1.09	0.88	1.03	7.53
	(0.74)	(0.90)	(0.72)	(0.82)	(0.71)	(0.86)	(0.66)	(0.69)	(4.88)
Sad	0.28	0.69	0.75	0.44	0.38	0.41	0.84	0.50	4.28
	(0.52)	(0.74)	(0.76)	(0.62)	(0.55)	(0.61)	(0.85)	(0.57)	(3.79)
Happy	0.69	1.13	0.91	1.06	0.50	0.81	1.47	0.75	7.31
	(0.90)	(0.79)	(0.89)	(0.84)	(0.67)	(0.97)	(0.95)	(0.80)	(5.31)

Note. Standard deviations are in parentheses.

Recall. Table 8 presents the mean proportions of list items and critical lures recalled for each mood group. All analyses were carried out using an arcsine transformation of those proportions. As in Experiment 2, a similar 3 (mood state) X 2 (item type) ANOVA was conducted on these data. Results revealed that neither the main effects nor the interaction between the two factors was significant.

The number of noncritical intrusions produced for each group were similar ($M=0.05$, $SD=0.06$ for neutral mood; $M=0.06$, $SD=0.05$ for sad mood; $M=0.05$, $SD=0.04$ for happy mood). A one-way ANOVA performed on the intrusions showed that the main effect of groups was not significant.

Recognition. Table 9 presents the mean proportions of list items and critical lures recognized for the three mood groups. A 3 (mood state) X 2 (item type) ANOVA was conducted on the arcsine transformation of the number of items recognized. Results revealed a significant main effect of

Table 8 ***Proportions of list items and critical lures recalled in Experiment 3.***

Mood states	Item type	
	List	Critical
Neutral	0.28	0.31
	(0.08)	(0.23)
Sad	0.28	0.26
	(0.09)	(0.19)
Happy	0.30	0.28
	(0.08)	(0.19)

Note. Standard deviations are in parentheses.

item type, F (1, 96) $=445.47$, $MSE=0.02$. No other effects reached statistical significance.

To further investigate the mood effect, we calculated participants' mean confidence ratings, as in previous experiments. For the list items, the mean confidence ratings were 2.81 ($SD=0.17$), 2.74 ($SD=0.26$), and 2.78 ($SD=0.19$) for the neutral, sad, and happy mood groups, respectively. Means for the critical lures were 2.93 ($SD=0.22$), 2.83 ($SD=0.44$), and 2.91 ($SD=0.23$) for the neutral, sad, and happy mood groups, respectively. A 3 (mood state) X 2 (item type) ANOVA performed on the confidence ratings revealed no significant main effect and no significant interaction between the two

Table 9 ***Proportions of list items and critical lures recognized in Experiment 3.***

Mood states	Item type	
	List	Critical
Neutral	0.86	0.54
	(0.13)	(0.12)
Sad	0.91	0.53
	(0.08)	(0.12)
Happy	0.92	0.54
	(0.08)	(0.09)

factors.

The "false alarm" rates were again equivalent for groups (M=0.05, SD=0.07 for neutral mood; M=0.04, SD=0.05 for sad mood; M=0.04, SD=0.05 for happy mood). A one-way ANOVA performed on the "false alarm" rates showed that the main effect of groups was not significant.

Discussion

Again, we failed to replicate the Experiment 1 results that negative mood reduced the false recall and false recognition of the critical non-presented lures. These null results are not attributable to the failure of the music mood induction. If one compares the intensity of mood ratings after mood induction in Experiment 2 and 3, it appears that the difference between the neutral and sad groups is larger here because of higher values in the neutral mood group (from 5.79 in Experiment 2, to 7.53 in Experiment 3), but no changes were evident for the sad mood group (4.73 vs. 4.28, respectively). In addition, although, as in Experiment 2, an additional analysis was performed with the data excluded for those participants whose mood states were unaffected by the mood inductions of sadness and happiness, we obtained the same conclusions.

It is not clear why the null results emerged, although they may be attributable to differences among participants. In Experiment 1 and 2, almost all participants were freshmen recruited from an introductory psychology course. In contrast, the majority of participants in Experiment 3 were seniors and psychology majors recruited from the department of psychology. Since they were not always naive as to the purpose of the memory experiment, they might have adopted effective mnemonic strategies such as rehearsal or mental imagery to discriminate list items from critical lures. In fact, it should be noted that a comparison of Experiment 2 and 3 shows a notable decrease of the recognition frequency of critical lures. That is, the proportions of critical lures recognized in Experiment 2 were 0.81, 0.87, and 0.88, for the neutral, sad, and happy moods, respectively. In Experiment 3 these values were 0.54, 0.53, and 0.54, for the neutral, sad, and happy moods, respectively.

General Discussion

The present sets of experiments attempted to determine whether negative mood state reduces the production of false recall and false recognition memories. In Experiment 1, the results showed that participants with negative mood recalled and recognized less proportion of the critical non-presented lures than did the participants with neutral mood. These results supported the hypothesis that the emergence of false memories is in part due to the lack of distinctive information at encoding. However, in Experiments 2 and 3, we failed to replicate these results. The absence of a facilitative effect of negative moods on false memories runs counter to the automatic activation-based hypothesis that considers the creation of false memories to be the consequence of automatic spreading of activation. Since this conclusion is based on a null finding, more systematic research needs to be conducted to test the plausibility of the automatic activation-based hypothesis.

Why did we fail to provide a straightforward replication of Experiment 1? One possibility is that the processing strategies mediated by the emotional moods were not effective enough to influence memory performance. In particular, it is possible that the presentation rate (2 sec per word) used in the experiments may have been too short for participants in the mood groups to engage in the predicted processing strategies. Therefore, slower presentation rates would provide more time to engage in the appropriate processing of the list items, such as systematic elaboration in the sad mood group or general knowledge-based processing in the happy mood group.

Another possible reason is that recall and recognition tests are insensitive to mood effects. Previous studies demonstrated that while mood effects have been found in recall, comparable effects have not always been found in recognition. We found no mood effect on recognition in Experiments 2 and 3, although negative mood reduced the false recognition of non-presented lures in Experiment 1. However, the recognition data from the present set of experiments need to be interpreted cautiously, as the recognition test always followed the recall test, and consequently was contaminated by prior recall. Hunt and his colleagues (Einstein & Hunt, 1980, Hunt & Einstein, 1981; Hunt & McDaniel, 1993; Hunt & Seta, 1984) proposed that organization and distinctiveness differentially influence memory performance. Recall performance is considered to be best under conditions that encourage participants' attention to both the item (i.e. distinctiveness) and the relationship among items (i. e., organization). According to their assumption, semantically-related materials bias organizational processing while unrelated materials encourage distinctive processing. In the present experiments, the words in the five sublists were semantically related. However, it seems that participants did not focus their attention to organization since they were presented with one long list of words and were not informed of the semantic relatedness of the list. In addition to this, they could encode little distinctiveness due to the rapid presentation rates. As a result, we failed to detect the influence of moods on overall recall performance. Therefore, given circumstances that encourage both distinctiveness and organization, we may be able to obtain mood effects substantial enough to test the distinctive information-based hypothesis. Clearly, more research is needed.

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Appendix

Word sublists used in the present studies. (Originally in Japanese)

order: army, obey, higher officer, command, obedience, boss, give, instructions, instruct, superior, absolute, teacher, repellence, listen, resistance

election : candidate, voting, be defeated, candidacy, speech, be elected, the House of Councilors, reelection, noisy, poster, elect, injustice, violation, purchase, car

pain : agony, pang, endure, injury, painful, sting, anguish, hurt, illness, stomachache, headache, pleasure, stomach, painless, medicine

war : tank, atomic bomb, fires, nuclear weapon, disturbances, fight, cannon, peace, bomb, Hiroshima, gun, conflict, destruction, battle, renunciation

suicide : hang, will, leap, bullying, die together, attempted, voluntary death, initiative death, die, death, railway, newspaper, murder, act, homicide