Research Report

Remembering Can Cause Forgetting—but Not in Negative Moods

Karl-Heinz Bäuml and Christof Kuhbandner

Regensburg University, Regensburg, Germany

ABSTRACT—*Repeated retrieval of a subset of previously observed events can cause forgetting of the nonretrieved events. We examined how affective states experienced during retrieval modulate such retrieval-induced forgetting by inducing positive, negative, and neutral moods in subjects immediately before they attempted to retrieve studied items. On the basis of recent work, we hypothesized that positive moods encourage relational processing, which should increase interference from related events and thus enhance retrieval-induced forgetting. By contrast, negative moods should encourage item-specific processing, which should reduce interference and thus reduce such forgetting. Our results are consistent with these predictions. When subjects were in negative moods, repeated retrieval did not cause forgetting of the nonretrieved material, whereas when subjects were in positive and neutral moods, they showed reliable retrieval-induced forgetting. Our findings suggest that the emotions involved during interrogation of a witness can affect the result of repeated interrogations.*

Mild induced mood states affect a variety of cognitive processes, including attention (e.g., Mischel, Ebbesen, & Zeiss, 1973), reasoning (e.g., Oaksford, Morris, Grainger, & Williams, 1996), and decision making (e.g., Arkes, Herren, & Isen, 1988). They also affect memory performance. These effects on memory can be different for positive and negative mood states. Gray (2001), for instance, found that positive moods can enhance performance on verbal tasks and that negative moods can reduce such performance. Storbeck and Clore (2005) reported high levels of false memories when subjects were in positive moods and a reduction in false memories when subjects were in negative moods. The goal of the research we report here was to investigate how affective states might influence retrieval-induced forgetting, forgetting that is caused by the retrieval process itself.

Address correspondence to Karl-Heinz Bäuml, Department of Experimental Psychology, Regensburg University, 93040 Regensburg, Germany, e-mail: karl-heinz.baeuml@psychologie.uni-regensburg.de.

The repeated retrieval of a subset of previously observed events can cause later forgetting of the nonretrieved events (see Anderson, 2003, for a review). For instance, if individuals learn items from different semantic categories (e.g., *fruit-apple*, *fruit-banana*, *drink-vodka*) and repeatedly retrieve half of the items from half of the categories (e.g., *fruit-ap___*), their later recall of the nonretrieved items from the practiced categories (*banana*) is often impaired, relative to their recall of control items from the unpracticed categories (*vodka*). Such retrieval-induced forgetting is a recall-specific effect (Anderson, Bjork, & Bjork, 2000; Bäuml, 2002) and is assumed to result from inhibitory control mechanisms operating during the repeated retrieval of the practiced items (Anderson & Spellman, 1995). During the attempts to retrieve, the not-to-be-retrieved items (*banana*) are thought to interfere and to be inhibited in order to reduce interference and make selection of the target information easier.

The question of whether emotion affects retrieval-induced forgetting encompasses two related but separate questions. One is whether retrieval-induced forgetting differs for emotional and neutral contents, independently of people's affective states during retrieval. The other is whether the affective state experienced during retrieval influences forgetting, independently of the contents to be retrieved. Although the first question has already been addressed in prior work (Amir, Coles, Brigidi, & Foa, 2001; Barnier, Hung, & Conway, 2004), the question of how affective states experienced during retrieval modulate the forgetting is largely unexamined to date. The answer to this question is important, as it may provide information on the interplay between mood and episodic forgetting.

The answer to this second question may also be important for applied issues. For example, an eyewitness is often questioned repeatedly, with a focus on certain aspects of the original event, which can cause later forgetting of the other aspects of the event

Copyright © 2007 Association for Psychological Science

(MacLeod, 2002; Shaw, Bjork, & Handal, 1995). Whether as a result of personal relationships, important social issues, or some positive or negative evaluation of the original event, emotions are likely to be involved in such repeated interrogations. Thus, knowledge about how affective states experienced during retrieval influence forgetting may provide information on whether mood can affect the result of repeated interrogations.

Results from prior work suggest that emotions can influence how information is processed. In particular, there is evidence that negative emotions result in predominantly item-specific processing, and positive emotions result in predominantly relational processing. Item-specific processing involves processing events by their features and distinctive qualities; relational processing involves processing events in relation to other concepts in memory (e.g., Hunt & McDaniel, 1993). False memories that result from spreading activation to a critical concept (Roediger, Balota, & Watson, 2001; Roediger & McDermott, 1995), for instance, are reduced if individuals are forced to process events in an item-specific way (Hege & Dodson, 2004). Likewise, such false memories are reduced when subjects are in negative moods, compared with positive moods, which suggests that negative emotions enhance item-specific processing and positive emotions enhance relational processing (Storbeck & Clore, 2005; for further evidence, see Bless et al., 1996; Fiedler, 2001; or Isen & Daubman, 1984).

Mood may affect retrieval-induced forgetting as well. Retrieval-induced forgetting presupposes relational processing. During retrieval of to-be-practiced items (e.g., *fruit-ap___*), only related items (*fruit-banana*) should interfere and be inhibited to reduce interference (Anderson, 2003). Consistently, retrieval-induced forgetting has been found to be eliminated if individuals process events in an item-specific way (R.E. Smith & Hunt, 2000). If negative moods experienced during retrieval induce item-specific processing, then negative moods may reduce interference and thus may reduce inhibition and later forgetting of the nonretrieved information. By contrast, if positive moods are experienced during retrieval and relational processing is induced, then positive moods may lead to an increase in interference and thus may enhance forgetting. As a result, positive and negative moods may have opposing effects on retrieval-induced forgetting, enhancing it in the one case and reducing it in the other.

This study examined the role of affective states in retrieval-induced forgetting. Subjects studied episodic material and then were asked to repeatedly retrieve a subset of the material. Immediately before retrieval, positive, negative, or neutral moods were induced. We examined whether mood affected later recall of the nonretrieved material.

METHOD

Subjects

Twenty-seven students at Regensburg University, Germany, participated in the experiment. They were tested individually.

Materials

We constructed six word lists, each consisting of items from three semantic categories. For each category, six emotionally neutral words were selected from published norms (Battig & Montague, 1969; Mannhaupt, 1983). The initial letter of each word was unique within its category.

Ten positive, 10 negative, and 10 neutral pictures were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999), a series of pictures with standardized ratings for valence and arousal.[1] The pictures showed people with diseases, mutilated bodies, erotic scenes, babies, scenery, or objects. Mean arousal for positive ($M = 6.1$) and negative ($M = 6.4$) pictures was equated and differed from that for the neutral pictures ($M = 2.6$), $F(1, 28) = 157.8$, $p_{rep} > .99$, $\eta^2 = .85$. Positive and negative pictures of the IAPS can effectively induce emotions (e.g., Erk et al., 2003; A.P.R. Smith, Henson, Dolan, & Rugg, 2004). To assess the success of the emotion induction in the present experiment, we used the affect grid (Russell, Weiss, & Mendelsohn, 1989), which permits subjects to express their emotional experience on a nine-by-nine matrix varying along the dimensions of valence and arousal.

Design

We used a 3×3 design with the within-subjects factors of mood (positive, negative, neutral) and word type (practiced, unpracticed, control). For each subject, two of the six word lists were assigned to each of the three mood conditions. For each single list, the experiment consisted of four main phases: a study phase, a mood-induction phase, a retrieval-practice phase, and a final test phase. With the exception of the mood-induction phase, the phases were identical across lists. In the mood-induction phase, material of positive, negative, or neutral valence was presented depending on the mood condition. The assignment of the six lists to the three mood conditions was balanced across subjects. For each subject, the order of the six lists was determined by blocked randomization. Each of the two blocks contained one list from each mood condition. The mean position of each mood condition was equated across subjects. The subjects were presented all six lists within one experimental session.

For each of the six lists, in the retrieval-practice phase, subjects repeatedly attempted to retrieve half of the items from two of the three categories. In this way, three types of words were created: words that were retrieval practiced (P+ words), unpracticed words belonging to the same two categories as the practiced words (P− words), and unpracticed words from the unpracticed category, which served as control words (C words). Which categories and which exemplars within a category were practiced was counterbalanced across subjects.

[1] Lang et al. assessed the emotion evoked by the IAPS photographs using Likert-type rating scales ranging from 1 (*extremely negative*) to 9 (*extremely positive*) for the dimension of affective valence and from 1 (*low arousal*) to 9 (*high arousal*) for the dimension of emotional arousal.

Procedure

The procedure was the same for each list. In the study phase, each word on a list was displayed on a computer screen for 5 s together with its category name. The order of presentation within a list was determined by blocked randomization. A random sequence of six blocks, each consisting of one randomly selected exemplar from each of the three categories, was presented to the subjects. After a 30-s distractor task, the mood-induction phase began. During this phase, the subjects were successively shown five pictures of the same valence and were told to let the pictures influence their emotional state. Each picture was presented for 6 s.

The retrieval-practice phase followed directly after the presentation of the last picture. The subjects were presented the word stem of each P+ word together with its category name and were asked to complete the stem with a studied word. The subjects were tested orally. Each word stem was presented twice at an exposure rate of 2.5 s per stem. The order was determined by blocked randomization, resulting in two blocks with six different word stems each. Subsequently, mood was measured using the affective grid. After another 3-min distractor task, the final test phase began. The subjects were provided with the (unique within the category) first letter of each studied word together with its category name and were again asked to name the appropriate word. The order of presentation was blocked by category. Mean testing position of practiced and unpracticed categories was equated, as was mean testing position of P+ and P− words within the practiced categories.

The test phase was followed by a break of 30 s before the study phase of the next list began. After the first block of three lists, there was a longer break of 5 min.

RESULTS

Manipulation Check

Across conditions, subjects varied reliably in mood, as indicated by the valence measure (positive mood: $M = 6.4$; negative mood: $M = 5.4$; neutral mood: $M = 5.9$), $F(2, 52) = 12.5$, $p_{rep} > .99$, $\eta^2 = .42$. Arousal in the positive and neutral conditions ($M = 4.2$ and $M = 4.0$, n.s.) differed reliably from arousal in the negative condition ($M = 4.9$), p_{rep}s $> .97$, $\eta^2 > .15$.

Retrieval-Practice Phase

Retrieval success in the retrieval-practice phase was high and did not vary reliably across mood conditions (positive mood: $M = 85.2\%$; negative mood: $M = 82.3\%$; neutral mood: $M = 79.0\%$), $p_{rep} = .83$.

Final Recall Test

Recall rates in the final test phase are shown in Figure 1. To determine whether mood affected the beneficial effect of retrieval practice on recall of P+ words, we conducted a 2 (word type: P+ words, C words) × 3 (mood: positive, negative, neutral) analysis of variance. The analysis revealed a significant main effect of word type, $F(1, 26) = 155.7$, $p_{rep} > .99$, $\eta^2 = .86$, showing that retrieval practice enhanced later recall of the practiced words. There were no other significant effects, p_{rep}s $< .55$.

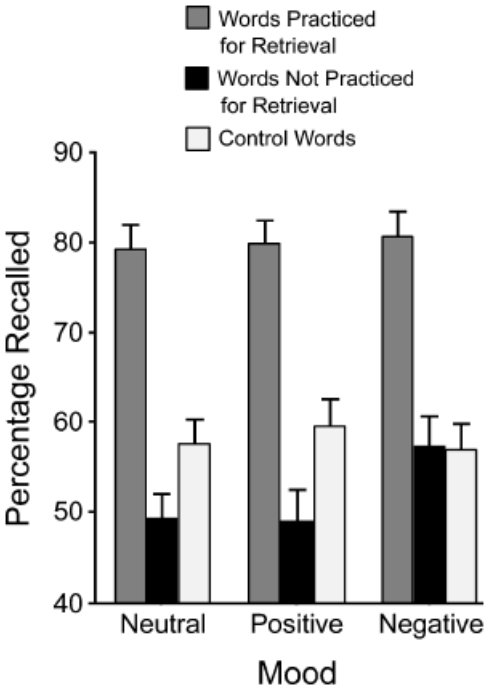

Fig. 1. Percentage recalled in the final test phase as a function of mood condition (neutral, positive, or negative) and word type (retrieval-practiced words, unpracticed words from the same categories as the retrieval-practiced words, or control words from unpracticed categories). The error bars represent standard errors.

To examine whether mood affected the detrimental effect of retrieval practice on recall of P− words, we conducted another 2 (word type: P− words, C words) × 3 (mood: positive, negative, neutral) analysis of variance. The analysis showed a significant main effect of word type, $F(1, 26) = 14.5$, $p_{rep} = .99$, $\eta^2 = .36$, and a significant interaction between the two factors, $F(2, 52) = 3.3$, $p_{rep} = .92$, $\eta^2 = .11$. Only in the positive-mood and neutral-mood conditions was performance reliably lower for the P− words than for the C words, $F(1, 26) = 8.2$, $p_{rep} = .97$, $\eta^2 = .24$, and $F(1, 26) = 12.5$, $p_{rep} = .99$, $\eta^2 = .33$; in the negative-mood condition, recall of the P− words was slightly higher than recall of the C words. Amount of forgetting differed reliably between the positive-mood and the negative-mood conditions, $F(1, 26) = 4.4$, $p_{rep} = .92$, $\eta^2 = .15$.

The results from the manipulation check suggest a difference in arousal between the positive-mood and the negative-mood conditions. A balanced median split of the subjects into a high-arousal group ($M = 5.8$) and a low-arousal group ($M = 3.7$) in the negative-mood condition indicated that the difference in arousal did not affect forgetting. Neither of the two groups showed lower recall rates for the P− words than the C words (56.1% vs. 56.1% and 59.0% vs. 58.3%); thus, the results for the sample as a whole were replicated.

DISCUSSION

Affect can influence retrieval-induced forgetting. When negative affect was experienced in the retrieval-practice phase, retrieval practice did not cause forgetting of the nonretrieved words from the practice categories; in contrast, reliable forgetting was found when subjects experienced positive and neutral moods in the retrieval-practice phase. The result for the negative-mood condition is consistent with recent findings indicating that negative emotions induce predominantly item-specific processing (Bless et al., 1996; Storbeck & Clore, 2005). During the retrieval-practice phase, such item-specific processing may reduce or even eliminate interference from related events and thus reduce or eliminate inhibition and retrieval-induced forgetting. Indeed, this is exactly what the present results revealed.

Recent findings have also indicated that positive emotions induce predominantly relational processing (Isen & Daubman, 1984; Storbeck & Clore, 2005). During the retrieval-practice phase, such relational processing may enhance interference from related events and thus may increase inhibition and retrieval-induced forgetting. Our results show a tendency for more forgetting in the positive-mood than in the neutral-mood condition, although the difference was not significant. The lack of a significant difference may be due to the fact that establishing a true affective neutral point is often problematic; neutral and positive moods often lead to similar behavior and similar neural patterns (Baker, Frith, & Dolan, 1997; Diener & Diener, 1996). Also, the relational processing that underlies retrieval-induced forgetting in neutral moods may be the default mode for any nonnegative state, so interference may already have reached ceiling in the neutral-mood condition (see Storbeck & Clore, 2005, for a related conclusion regarding false memories). In this case, our results primarily demonstrate the influence of negative moods on retrieval-induced forgetting, indicating that a change from the (default) relational mode to an item-specific mode of retrieval can eliminate the forgetting.

The present results suggest that mood may influence eyewitness testimony. Using meaningful stimuli that could be experienced under eyewitness situations, previous studies showed that repeated interrogations can reduce later recall of the nonretrieved events (MacLeod, 2002; Shaw et al., 1995), and false recollections may be induced if misinformation regarding the nonretrieved events is provided after interrogation (Saunders & MacLeod, 2002). The present results suggest that these two effects may arise if the witness is in a neutral or positive mood. If the witness is in a negative mood, however, these effects may be reduced, if not eliminated.

This study addressed the question of whether the affective state experienced during retrieval influences forgetting, independently of the valence of the contents being retrieved. In contrast, two previous studies addressed the question of whether retrieval-induced forgetting differs for emotional and neutral content, independently of people's affective state during retrieval. One of those studies used positive and negative autobiographical memories as the stimuli (Barnier et al., 2004), and the other examined memory for positive and negative social words in social phobics and nonanxious control subjects (Amir et al., 2001). For social phobics, no retrieval-induced forgetting arose for negative social words, a result that mimics the present finding. For all other individuals, in the two studies, retrieval-induced forgetting was present for positive and negative words. The effect of emotion on retrieval-induced forgetting thus appears to be largely restricted to the affective states experienced during retrieval. At least when people are in negative moods, their affective states can prevent remembering from causing forgetting.

Acknowledgments—The research reported here was supported by a grant from the German Research Foundation (DFG) to Karl-Heinz Bäuml (Ba 1382/7-1).

REFERENCES

Amir, N., Coles, M.E., Brigidi, B., & Foa, E.B. (2001). The effect of practice on recall of emotional information in individuals with generalized social phobia. *Journal of Abnormal Psychology*, *110*, 76–82.

Anderson, M.C. (2003). Rethinking interference theory: Executive control and the mechanism of forgetting. *Journal of Memory and Language*, *49*, 415–445.

Anderson, M.C., Bjork, E.L., & Bjork, R.A. (2000). Retrieval-induced forgetting: Evidence for a recall-specific mechanism. *Psychonomic Bulletin & Review*, *7*, 522–530.

Anderson, M.C., & Spellman, B.A. (1995). On the status of inhibitory mechanisms in cognition: Memory retrieval as a model case. *Psychological Review*, *102*, 68–100.

Arkes, H.R., Herren, L.T., & Isen, A.M. (1988). The role of potential loss in the influence of affect on risk-taking behavior. *Organizational Behavior and Human Decision Processes*, *42*, 181–193.

Baker, S., Frith, C., & Dolan, R. (1997). The interaction between mood and cognitive function studied with PET. *Psychological Medicine*, *27*, 565–578.

Barnier, A.J., Hung, L., & Conway, M.A. (2004). Retrieval-induced forgetting of emotional and unemotional autobiographical memories. *Cognition and Emotion*, *18*, 457–477.

Battig, W.F., & Montague, W.E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monographs*, *80*(3, Pt. 2), 1–46.

Bäuml, K.-H. (2002). Semantic generation can cause episodic forgetting. *Psychological Science*, *13*, 357–361.

Bless, H., Clore, G.L., Schwarz, N., Golisano, V., Rabe, C., & Wolk, M. (1996). Mood and the use of scripts: Does a happy mood really lead to mindlessness? *Journal of Personality and Social Psychology*, *71*, 665–679.

Diener, E., & Diener, C. (1996). Most people are happy. *Psychological Science*, *7*, 181–185.

Erk, S., Kiefer, M., Grothe, J., Wunderlich, A.P., Spitzer, M., & Walter, H. (2003). Emotional context modulates subsequent memory effect. *NeuroImage*, *18*, 439–447.

Fiedler, K. (2001). Affective states trigger processes of assimilation and accommodation. In L.L. Martin & G.L. Clore (Eds.), *Theories of mood and cognition: A user's guidebook* (pp. 86–98). Mahwah, NJ: Erlbaum.

Gray, J. (2001). Emotional modulation of cognitive control: Approach-withdrawal states double-dissociate spatial from verbal two-back task performance. *Journal of Experimental Psychology: General*, *130*, 436–452.

Hege, A.C.G., & Dodson, C.S. (2004). Why distinctive information reduces false memories: Evidence for both impoverished relational-encoding and distinctiveness heuristic accounts. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30*, 787–795.

Hunt, R., & McDaniel, M. (1993). The enigma of organization and distinctiveness. *Journal of Memory and Language*, *32*, 421–445.

Isen, A.M., & Daubman, K.A. (1984). The influence of affect on categorization. *Journal of Personality and Social Psychology*, *47*, 1206–1217.

Lang, P.J., Bradley, M.M., & Cuthbert, B. (1999). *International Affective Picture System (IAPS): Technical manual and affective ratings*. Gainesville: University of Florida, Center for Research in Psychophysiology.

MacLeod, M.D. (2002). Retrieval-induced forgetting in eyewitness memory: Forgetting as a consequence of remembering. *Applied Cognitive Psychology*, *16*, 135–149.

Mannhaupt, H.-R. (1983). Produktionsnormen für verbale Reaktionen zu 40 geläufigen Kategorien. *Sprache & Kognition*, *2*, 264–278.

Mischel, W., Ebbesen, E., & Zeiss, A. (1973). Selective attention to the self: Situational and dispositional determinants. *Journal of Personality and Social Psychology*, *43*, 1244–1255.

Oaksford, M., Morris, F., Grainger, B., & Williams, J.M.G. (1996). Mood, reasoning and central executive processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 476–492.

Roediger, H.L., III, Balota, D., & Watson, J. (2001). Spreading activation and arousal of false memories. In H.L. Roediger, III, J. Nairne, I. Neath, & A.M. Surprenant (Eds.), *The nature of remembering: Essays in honor of Robert G. Crowder* (pp. 95–115). Washington, DC: American Psychological Association.

Roediger, H.L., III, & McDermott, K.B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 803–814.

Russell, J.A., Weiss, A., & Mendelsohn, G.A. (1989). The affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology*, *57*, 493–502.

Saunders, J., & MacLeod, M.D. (2002). New evidence on the suggestibility of memory: The role of retrieval-induced forgetting in misinformation effects. *Journal of Experimental Psychology: Applied*, *8*, 127–142.

Shaw, J.S., III, Bjork, R.A., & Handal, A. (1995). Retrieval-induced forgetting in an eyewitness-memory paradigm. *Psychonomic Bulletin & Review*, *2*, 249–253.

Smith, A.P.R., Henson, R.N.A., Dolan, R.J., & Rugg, M.D. (2004). fMRI correlates of the episodic retrieval of emotional contexts. *NeuroImage*, *22*, 868–878.

Smith, R.E., & Hunt, R.R. (2000). The influence of distinctive processing on retrieval-induced forgetting. *Memory & Cognition*, *28*, 503–508.

Storbeck, J., & Clore, G.L. (2005). With sadness comes accuracy; with happiness, false memory. *Psychological Science*, *16*, 785–791.

(Received 3/30/06; Revision accepted 5/19/06;
Final materials received 6/5/06)