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Effects of repeated retrieval of central and peripheral details in complex emotional slides

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Abstract

Research has demonstrated that repeated retrieval enhances memory for practiced verbal information, but undermines correct recall of unpracticed related verbal information, a phenomenon known as retrieval-induced forgetting (RIF). This paper addresses the question of what happens with memory for unrehearsed aspects of an emotional picture when retrieval of other aspects of that picture is practiced. We investigated in 2 experiments whether repeated retrieval of certain details of negative emotional slides undermines recall of unrehearsed details of such slides. In experiment 1, retrieval of peripheral details was practiced. The results demonstrated that recall for peripheral details was enhanced. However, correct recall of unpracticed central details remained unaffected. Furthermore, retrieval practice did not alter the number of commission errors. Experiment 2 revealed that repeated retrieval of central details enhanced memory for these details. Although more commission errors were produced, again correct recall was not impaired for the unrehearsed central and peripheral details. This failure to find retrieval-induced forgetting effects for complex visual material is at odds with the RIF literature, and potential reasons for this are discussed. The data also extend previous studies in demonstrating that extensive retrieval can increase the number of commission errors.

Keywords: central and peripheral detail memory, commission errors, eyewitness testimony, intrusive memory, retrieval-induced forgetting

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Emotional events are strongly encoded in memory (e.g., Cahill, Gorski, & Le, 2003; Cahill & McGaugh, 1998). Emotional memories also tend to be frequently rehearsed over time (e.g., Conway et al., 1994; Finkenauer et al., 1998). However, it is plausible to assume that not all aspects of an emotional event are rehearsed equally well. For instance, people with Posttraumatic Stress Disorder (PTSD) persistently re-experience some parts of a traumatic event in the form of intrusive memories (American Psychiatric Association [APA], 1994; Brewin, 1998). In contrast, they might be unable to recall other aspects of that same event, a phenomenon that some researchers have related to dissociative amnesia (e.g., Holmes et al., 2005; see also APA, 1994). Another relevant example is eyewitness testimony. Police interviewers will often focus on particular key details of a crime but, what happens with eyewitness memory for other, unrehearsed details? There is some experimental evidence to suggest that memory for these aspects deteriorates as a result of rehearsal of the key details (e.g., Wright, Loftus, & Hall, 2001).

Relevant to the issue of rehearsal effects are studies using Anderson and colleagues' retrieval practice paradigm (e.g., Anderson, Bjork, & Bjork, 1994; Anderson & Spellman, 1995). This paradigm offers a way to investigate the impact of repeated retrieval of particular information on recall of unrehearsed information. The paradigm typically consists of three phases and relies on word stimuli (e.g., Anderson et al., 1994). During a study phase, participants learn a number of category-exemplar associations (e.g., Fruit-Banana; Fruit-Orange; Garden-Tree). Subsequently, participants are directed to retrieve half of the studied exemplars from half of the categories by completing category-stem pairs (e.g., Fruit-Ba__). In this retrieval practice phase, the critical exemplars are practiced three times. After a distracter phase, participants

engage in a cued recall test. They are cued with a category name (e.g., Fruit, Garden) to recall *all* of the exemplars from *all* of the categories that were presented in the study phase. There are thus three types of exemplars: practiced exemplars (Fruit-Banana), unpracticed related exemplars (Fruit-Orange), and unpracticed unrelated exemplars (Garden-Tree). Typically, recall for practiced exemplars (Fruit-Banana) is enhanced. This is called the retrieval practice effect. The more interesting result is that fewer unpracticed related exemplars (Fruit-Orange) than unpracticed unrelated exemplars (Garden-Tree) are recalled. This outcome is dubbed *retrieval-induced forgetting* (Anderson et al., 1994). According to Anderson et al. (1994), this forgetting is caused by inhibition of competing exemplars that are associated with the same (retrieval) cue as the retrieval-practiced exemplars (but see MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003). The retrieval-induced forgetting effect has been replicated with a variety of stimulus material (for a review see Levy & Anderson, 2002).

The question arises as to whether a similar pattern occurs with more complex and emotional situations in real life. Thus, for example, one could speculate that dissociative amnesia for particular aspects of a traumatic event is a consequence of (persistent) repeated retrieval of certain other aspects of the same traumatic events in the form of intrusive memories (see also Brewin & Andrews, 1998). Similarly, repetitive police interviews about particular aspects of a serious crime may result in forgetting other details related to that same offence. Indeed, several studies (MacLeod, 2002; Saunders & MacLeod, 2002; Shaw, Bjork, & Handal, 1995) have demonstrated that repeated questioning enhances participants' memory for the rehearsed aspects, but promotes forgetting of the unrepeated details. Additionally, some studies have demonstrated retrieval-induced forgetting for emotional material (e.g., Amir, Coles, Brigidi, & Foa 2001; Barnier, Hung, & Conway, 2004). For example, two studies (Barnier et al., 2004; Wessel &

Hauer, 2006) showed that retrieval practice of emotional autobiographical memories impaired recall of unpracticed autobiographical memories that were related to the same cue. Taken together, these results do not only imply that retrieval-induced forgetting can be generalized to emotional material, but also to more complex material than, for example, words.

So far we have restricted our discussion to the effect of repeated retrieval on subsequent recall of unrehearsed information. However, apart from retrieval, encoding might also be responsible for differential recall. Research has shown that not all aspects of emotional stimuli are encoded equally well (e.g., Christianson, 1992; Heuer & Reisberg, 1990). For example, several studies (Christianson & Loftus, 1987; 1991) compared memory for emotional and neutral slides revealing that central details (i.e., information reflecting the essence) of emotional slides are better retained than those of neutral slides. In many studies, the opposite is found for peripheral details (i.e., thematically irrelevant information), with memory of peripheral details being poorer for emotional than for neutral material (but see Wessel, van der Kooy, & Merckelbach, 2000, for boundary conditions). According to the attentional narrowing hypothesis (see Christianson, 1992), the physiological arousal that accompanies experiencing negative emotional events results in devoting more attention to central details than to peripheral details. Consequently, superior encoding of central details enhances memory for these details, but undermines memory for peripheral details. This possibly also makes peripheral details more prone to commission errors (i.e., adding or distorting details, e.g., Candel, Merckelbach, & Zandbergen, 2003; Heuer & Reisberg, 1990). For example, Heuer and Reisberg (1990) noted that most commission errors occur for poorly encoded details (i.e., peripheral aspects) and that such errors are consistent with pre-existent cognitive schemata of emotional situations.

The present experiments investigated whether the typical pattern of recalling central and peripheral details of emotional material is affected when these details are subjected to differential rehearsal. This issue was addressed in 2 experiments. Inspired by the retrieval practice literature, we used a repeated retrieval method with negative emotional slides to investigate the effect of repeated retrieval of either peripheral (experiment 1) or central (experiment 2) details on the recall of unrehearsed central and peripheral details. Whereas previous studies using complex emotional material focused on complete memories (e.g., Barnier et al., 2004; Wessel & Hauer, 2006), the present experiments focus on different types of details of complex visual scenes.

Experiment 1

Experiment 1 investigated whether repeated retrieval of peripheral aspects of emotional slides would alter the pattern typically observed in studies on central and peripheral detail memory, i.e. good recall of central details and poor recall of peripheral details (Christianson, 1992; see also Reisberg & Heuer, 2004). Following Christianson (1992), central details were defined as all details that reflect the gist of the visual scene (i.e., thematically essential to the slide). Details that were not relevant to the essential theme (i.e., that can be left out without changing the gist of the visual scene) were counted as peripheral details. A between-subjects design was employed (compare Shaw et al., 1995), in which the experimental condition involved repeated retrieved of peripheral details. In contrast, the control condition involved an unrelated task.

Experiment 1 addressed the question of whether repeated retrieval of peripheral details undermines memory for central details. Although repeated retrieval of central detail may perhaps more closely mimic the real-life situations as described above, we explicitly chose to examine

the effect of retrieval practice of *peripheral* details for two reasons. Firstly, ceiling and floor effects might easily occur due to attentional narrowing at encoding. That is, on the one hand, central details are expected to be well encoded, leaving little room for repeated retrieval to improve their recall even further. On the other hand, encoding of peripheral details would be relatively poor already, prohibiting any further worsening at recall due to retrieval practice. Indeed, extensive pilot work in our lab has demonstrated that repeated retrieval of central details did not significantly improve their recall, neither did it lower peripheral detail recall.[1]

Secondly, and more importantly, there are theoretical reasons to expect that rehearsal of peripheral rather than central detail would render substantial retrieval-induced forgetting. According to inhibition theory (see Anderson, 2003), retrieval-induced forgetting would be more pronounced when unpracticed related items are strong rather than weak exemplars of a category. The idea is that strong exemplars have a high probability of being accessed during a retrieval practice phase, even if they are not explicitly practiced. Competition between strongly associated target and non-target exemplars during retrieval practice, it is argued, therefore needs to be resolved by suppression of non-target exemplars. Subsequently, cued recall of these putatively suppressed non-target exemplars should be relatively poor. Indeed, earlier studies (Anderson et al., 1994; Bäuml, 1998) showed larger retrieval-induced forgetting effects for strong rather than for weak exemplars of semantic categories. For the present purpose, we reasoned that central details are thematically essential for the slide and are thus likely to be strongly related to the retrieval cue. Peripheral details, on the other hand, are by definition thematically unimportant and may therefore be weakly associated with the title cues. Thus, during retrieval practice of peripheral details the central details should act as strong competitors.

All in all, concurring with the retrieval-induced forgetting literature (e.g., Anderson, 2003), we first hypothesized that retrieval practice of peripheral aspects would reduce correct recall of central details because these were highly competitive non-target items, relative to a no retrieval practice control condition. We also expected a retrieval practice effect in that participants who engaged in retrieval practice would recall more practiced peripheral details than control participants. Secondly, previous studies found that repeated retrieval of central details compromises the accuracy of peripheral details in the form of increased commission errors (i.e., adding or distorting details) for such details (Heuer & Reisberg, 1990) and that unrehearsed details become more susceptible to misinformation (Saunders & MacLeod, 2002). To the extent that commission errors for peripheral details in prior studies were a function of the retrieval manipulation (e.g., Henkel, 2004), we anticipated more commission errors for unpracticed central details.

Method

Participants. Fifty-nine second-year psychology students (20 men) from Maastricht University participated in this study. Mean age was 22.16 years (Range: 20-29). Participants were randomly assigned to one of two testing conditions, resulting in 30 participants in the control condition and 29 participants in the retrieval practice condition. The groups did not differ in mean age, t (57) = 1.64, p = .11, nor in sex ratio, $?^2$ (1) = 1.00, p = .32. All participants received course credit for their participation. The experiment was approved by the standing Ethical Committee of the Faculty of Psychology of Maastricht University.

Stimulus material. The stimulus material consisted of 5 negative emotional slides and one practice slide. All of the slides were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1998). These slides were selected on the basis of two criteria.

Firstly, slides had a negative valence (IAPS score below 3 on a 9-point scale) with high arousal (IAPS score above 5 on a 9-point scale). Secondly, in a pilot study (N = 8), participants were asked to examine 14 slides and to recall as many of the details as possible after having seen the slides for 5 s. The rationale was to determine the maximum number of details that could be recalled from the slides. Participants were also provided with the definitions of central and peripheral details presented above and were then asked to rate the details that they recalled on a 4-point scale (1 = "highly peripheral" to 4 = "highly central"). On the basis of this categorization, details were assigned to the central and peripheral categories.

Based on the pilot study, the 5 slides (IAPS numbers were 3350, 3530, 9250, 9253, 9433) were selected that contained sufficient and similar numbers of central and peripheral details. This was done to ensure that participants would have enough opportunity to encode peripheral details and to minimize possible floor effects. The total number of details in a category was the total of all details that were named by at least one of the pilot participants. The total number of details reflecting central objects of the slides was 66. There were some central details that did not reflect the central object, but that were nevertheless critical to the gist of the scene (e.g., the facial profile of a victim, where the attacker is the central object). The number of these details was 26. The total number of peripheral details was 57. The total number of details thus reflected a complete and accurate description of the details present in the slides. See figure 1 for an example of the different detail categories in the slides.

Furthermore, each slide was given a title to function as a category label. The titles of the experimental slides were: Sick baby (3350), Threat (3530), Social worker (9250), Injured woman (9253), and Wounded man (9433). Torture (9252) was the name of the example slide.

(Figure 1 about here)

Retrieval practice booklets. These contained retrieval practice questions about the peripheral details. Following the procedure of Shaw et al. (1995), three different types of retrieval practice questions were constructed. The first retrieval practice episode contained three true-false questions about each slide (for example, "Were there any bystanders on the slide?"). During the second retrieval episode, more specific questions were asked about the location of the peripheral details (for example, "Where were the bystanders standing?"). The third retrieval episode contained questions like "Describe the appearance of the bystanders". Thus, the questions asked for detailed descriptions of the peripheral details. Questions regarding each slide were rehearsed three times by presenting them in pseudo-random order. The questions were presented in 3 blocks, serially presenting all questions related to the 5 slides in one block. Questions regarding the same slide were never practiced in direct succession.

Distracter task. This was a non-verbal intelligence task in both conditions (Raven's Advanced Progressive Matrices; Raven, 2000).

Control condition. As an alternative to the retrieval practice phase, participants in the control condition already started with the Raven task (Raven's Progressive Matrices; Raven, 2000).

Test booklets. These booklets contained 5 pages. Each page presented the slide-title (e.g., Threat) in order to cue recall. The order of the slides was random and was different for each participant. All participants from both conditions were asked to recall aloud *all* of the details that they could remember. The experimenter wrote down in the test booklets everything that the participants said.

Procedure

Participants were tested individually. In the laboratory, all participants heard a cover story telling them that they were to take part in an experiment testing the impact of negative emotion on performance on a non-verbal intelligence task. Thus, the study phase was incidental. This was done to enhance ecological validity and to reduce the probability of elaborative encoding and thus integration between to-be-practiced and to-be-unpracticed details during the study phase. Previous work suggests that integration abolishes RIF effects (e.g., Anderson & McCulloch, 1999). Participants were told that the second experiment involved the validation of a non-verbal intelligence task. Nothing was said about the upcoming surprise cued recall task. Participants subsequently signed a consent form and electrodes were attached to their hands.

Participants sat approximately 1 m in front of a 66 x 91 cm Dell monitor on which full screen versions of the slides were shown. During the slide show (study phase), the lights were switched off to enhance emotional intensity. To begin, an example slide was shown, followed by the 5 critical slides in random order. Each trial consisted of the presentation of slide titles for 1.5 s, followed by presentation of the slides for 7 s. Intertrial intervals were 2 s. After watching the slide show, participants in the retrieval practice condition immediately worked through the retrieval practice booklets. This retrieval practice phase took 20 min. Participants were first instructed about the retrieval practice procedure and they practiced with the example slide. Next, using the retrieval practice booklets, the experimenter interviewed these participants by asking them the retrieval practice questions related to the peripheral objects. Control participants engaged in the unrelated intelligence task. Subsequently, all participants took part in the 10 min distracter task (Raven's Matrices).

Finally, all participants engaged in the cued recall test phase. With the slide titles as cues, participants were instructed to verbally recall all of the central and peripheral details of the slides

presented during the study phase. Participants were encouraged to report everything they could remember even if they thought it would be of no importance. After the test phase, participants were debriefed and thanked for their participation.

Scoring

Two types of dependent measures were scored: correctly recalled details and commission errors. Scoring was based on a detailed scoring protocol, containing extensive descriptions of correct details in three categories: central object details, central details, and peripheral details. A detail was defined as a piece of information that was visually present on the slide based on the pilot data described above. Each correctly reported detail received one point. For example, the correctly recalled phrase "red t-shirt with white lettering" received 4 points, whereas only recalling "red t-shirt" was scored with two points. Commission errors were defined as adding new information or distorting presented information. An example of adding new information is recalling "a house" that was not visually present on the slide. An example of distorting presented information is recalling a "blue t-shirt" or "red jacket" instead of "red t-shirt". Each piece of added or distorted information received one point.

All cued recall protocols were scored by an independent rater who was blind to the experimental conditions. A second rater (BH), who was also blind to the experimental conditions, scored all of the free recall reports of 20 randomly selected participants (29% of the sample): 10 reports even from the retrieval practice and control conditions. Intraclass Correlation Coefficients (ICC; see Fleiss, 1986) were computed. Interrater agreement was high. For correctly reported details, we found ICC's of .90 for the total number of recalled details, .92 for central details, and .86 for peripheral details. ICC's for commission errors were: .85 for total number of

commissions, .78 for commissions in the central details, and .85 for commissions in peripheral details.

Results and Discussion

Where relevant, raw data were converted into proportions based on the total number of details in the visual scene (see above).

For participants in the retrieval practice condition, the mean proportion of correctly recalled details in the retrieval practice phase was 34% (SD = 7.92). The mean number of reported unpracticed central object and central details during the retrieval practice phase was .48 (SD = .54). The mean number of reported commission errors during the retrieval practice phase was 2.11 (SD = 1.13).

Table 1 presents relevant means and standard errors for the proportions of correctly recalled details and the numbers of commission errors in the different detail categories in the test phase. All proportions were based on the total number of details as described in the method section. The 2 Retrieval Practice (yes vs. no) x 3 Detail (unpracticed central object vs. unpracticed central vs. practiced peripheral) mixed ANOVA yielded a main effect for detail, F (2, 57) = 95.93, p < .001. There was no main effect for retrieval practice, F (2, 57) < 1. However, there was a significant Detail x Retrieval Practice interaction, F (2, 57) = 3.86, p = .02. Follow-up independent sample t-tests demonstrated that the retrieval practice group significantly recalled more of the practiced peripheral details compared with controls, t (59) = 3.11, p = .003, showing a retrieval practice effect. There were no significant differences between groups in the correct recall of unpracticed central details, t (59) < 1, or unpracticed central object details, t (59) < 1.

In terms of commission errors, the 2 Retrieval Practice (yes vs. no) x 3 Detail (unpracticed central object vs. unpracticed central vs. practiced peripheral) mixed ANOVA

demonstrated a main effect for detail, F (2, 57) = 3.86, p = .02. Follow-up paired samples t-tests demonstrated no significant difference between the number of commission errors for unpracticed central object details and practiced peripheral details, t (60) < 1. However, participants did make more commission errors for the practiced peripheral details than for the unpracticed central details, t (60) = 4.45, p < .001, and for the unpracticed central object details than for unpracticed central details, t (60) = 5.11, p < .001. There was no significant main effect of retrieval practice, F (2, 57) < 1, and no significant Detail x Retrieval Practice interaction, F (2, 57) = 2.40, p = .10.

(Table 1 around here)

The present data showed a retrieval practice effect in that repeated retrieval of peripheral details enhanced memory for these details relative to the control condition. However, repeated retrieval of (peripheral) details did not significantly impair correct recall of unpracticed (central object) details. Thus, there was no evidence to support retrieval-induced forgetting. These data are at odds with findings from earlier studies employing a retrieval practice paradigm (e.g., Anderson et al., 1994; MacLeod, 2002; Saunders & MacLeod, 2002). Furthermore, retrieval practice did not result in more commission errors in the unpracticed detail categories.

A number of methodological issues merit some discussion here. First, one might question whether the retrieval practice phase in this experiment, indeed, induced effortful retrieval for all of the retrieval practice episodes. The reason for this concern is that in the first two retrieval practice episodes participants answered closed retrieval practice questions whereas in the third episode retrieval practice questions were open (cf. Shaw et al., 1995). Thus, the first two episodes in the retrieval practice phase may have tapped recognition rather than retrieval processes. Such recognition may have required less suppression of to-be-ignored unpracticed central (object) details, subsequently leading to unimpaired recall of unpracticed details.

Secondly, although the results of experiment 1 did show a significant retrieval practice effect, retrieval practice success rates of the practiced peripheral details were relatively low (34%). This, however, should not necessarily prevent retrieval-induced forgetting from occurring. That is, a recent study (Storm, Bjork, Bjork, & Nestojko, in press) showed retrieval-induced forgetting with impossible category members. Successful retrieval practice was made impossible because the two-letter stems in the retrieval practice phase did not correspond to the initial letters of any of the exemplars that were associated with the category in the study phase. Even with close to zero recall at practice, Storm et al. (in press) still obtained a retrieval-induced forgetting effect. One possibility for the present relatively low success rate is that preferential encoding of central details may have precluded successful encoding of the peripheral details in the study phase, thus leading to low retrieval practice success rates for the peripheral details. Related to this, it is possible that preferential encoding of central details was sufficiently strong that it inoculated them from putative retrieval-induced forgetting effects.

To summarize, although the present results demonstrated a retrieval practice effect, there was no evidence for retrieval-induced forgetting. Repeated retrieval did also not result in more commission errors in unpracticed details. Experiment 2 was set up to examine more closely why retrieval-induced forgetting did not emerge in this experiment.

Experiment 2

The first issue addressed in experiment 2 was the role of integration, meaning that the more the details are integrated with each other, the less likely it is for retrieval-induced forgetting to occur (e.g., Anderson & McCulloch, 1999; Bäuml & Kuhbandner, 2003). Note that integration of the to-be-practiced and/or to-be-ignored exemplars might play a role either at encoding or

during retrieval practice. Considering integration at encoding, experiment 1 employed an incidental study phase to attempt to minimise possible integration effects in this phase. The rationale was that being unprepared for a subsequent recall test would diminish the probability of effortful elaborative encoding of the details of the slides. However, it may be that details of a negative emotional scene elicit more *spontaneous* integration attempts than, say, details of neutral material, thereby making them less sensitive to retrieval practice effects. To examine whether retrieval-induced forgetting failed to occur because of the emotionally negative content of the slides, we therefore added a baseline condition in experiment 2 consisting of neutral slides that were matched with the negative ones.

As for integration during retrieval practice, the interview format of the previous experiment may have stimulated participants to integrate details. Consequently, while an interview procedure seems ecologically more valid (e.g., it is similar to police interrogations) this might not have provided the optimal method to induce retrieval-induced forgetting. We therefore decided to use a written retrieval practice procedure in this experiment in line with the previous literature (e.g., Anderson et al., 1994). In doing so, we expected to reduce integration and also to increase the retrieval practice success rate, i.e. the number of correctly recalled details in the retrieval practice phase.

The second issue addressed in experiment 2 concerned competition between the different detail categories within the slides. We argued earlier that peripheral details could be conceived as weak competitors and central details as strong competitors as a direct function of the strength of their relationship with the theme (gist) of a given slide. However, peripheral details need not necessarily to be weak competitors. Bäuml (1998) demonstrated that whether or not memory for unpracticed exemplars suffers as a function of repeated retrieval of related items depends on the

items' associative strength to the retrieval cue, with larger impairment when the category-exemplar association is strong and smaller or no impairment when the category-exemplar association is moderate or weak. The question arises as to whether the central-peripheral ratings of the pilot study preceding experiment 1 are indeed indicative of the nature of the association between the retrieval cues (slide-names) and details. Perhaps pilot participants based their judgements on other criteria than associative strength.

One way to investigate this would be to obtain relatedness ratings of the different detail categories both with the theme of the slide, and with each other. To this end, pilot studies were conducted to explore the strength of inter-associations between the detail categories and between the categories and the theme of the slide. Related to this, participants in the retrieval practice groups were asked to retrieval practice only half of the details of the central object category, leaving the remaining half unpracticed. In this way, we were able to investigate the effect of retrieval practice not only between the different detail categories (i.e., central object details vs. central details vs. peripheral details), but also within a detail category (i.e., practiced central object details vs. unpracticed central object details). It is possible that no retrieval-induced forgetting effects emerged in the previous experiment because of differences in the associative strengths of the central object detail, central detail and peripheral detail categories, with the retrieval cues, and this modification circumvents this problem.

In summary, in experiment 2 participants were assigned to one of four groups as there were two between-group factors. These were retrieval practice – yes or no – and valence – negative or neutral slides. Based on the previous literature we hypothesized that, due to retrieval practice, the recall of central object details in the practice groups would be higher than that in the control groups. Furthermore, we predicted that retrieval practice would impair the correct recall

of unpracticed central object details in the practice groups as compared to the control groups. Regarding valence, we hypothesized that these effects would be more pronounced in the neutral than in the negative slides, due to putative spontaneous integration effects for the valenced material.

Method

Participants. In experiment 2, 119 first- and second-year psychology students (28 men) from Maastricht University participated. Mean age was 20.61 years (SD = 3.10; Range: 18-40 years). Participants were randomly assigned to one of four testing conditions. There were 30 participants in the retrieval practice neutral condition, 28 participants in the control neutral condition, 31 participants in the retrieval practice negative condition, and 30 participants in the control negative condition. The groups did not differ in mean age, F (3, 115) = 2.18, p = .10, nor in sex ratio, $?^2$ (1, 3) = 2.34, p = .51. Participants received either course credit or € 7.50 for their participation.

Stimulus material. In a pilot study (N = 15), we presented the 5 negative slides, along with 10 neutral slides that were comparable with the negative slides in terms of complexity and number of details. The neutral slides were taken from different sources such as the internet and/or were composed by the experimenters. Participants were asked to rate all slides on valence and arousal on visual analogue scales (VAS; 0 = very negative/calm – 100 = very positive/aroused). They also indicated how many detail categories were present on the slide and rated on a VAS scale from 1 – 100 how strongly they judged the detail categories to be related to each other. They were also asked to identify the theme of the slide and to label the detail categories that they had delineated. Other participants (N = 20) rated on a VAS scale from 1 –

100 how strongly they found the detail categories to be related to the theme of the slide, as defined by the former pilot participants.

There were 3 pairs of negative and neutral slides were optimally matched on all of the criteria. The negative slides were the IAPS slides 3530 (Threat), 9250 (Social worker), and 9433 (Wounded man). One neutral slide was composed by the experimenters and the other two were taken from the internet. The neutral slides were rated as significantly more positive than the negative slides, means being $M = 57.30$ ($SD = 10.30$) and $M = 13.20$ ($SD = 10.00$), respectively, $t(14) = 10.98$, $p < .001$. The neutral slides elicited also less arousal than the negative slides, means being $M = 24.67$ (SD = 20.76) and $M = 61.38$ (SD = 14.74), respectively, $t(14) = 6.13$, $p < .001$. Pilot participants defined 3 different detail categories that corresponded to central object details, other central details, and peripheral details. The total number of details for the negative slides was 30 for the central object details, 23 for the central details, and 22 for the peripheral details. This was similar for the neutral slides: 33 for the central object details, 24 for the central details, and 22 for the peripheral details. For both the negative and the neutral slides, the central object detail and central detail categories were strongly inter-associated, 76.77 ($SD = 15.37$) and 69.06 ($SD = 18.33$), respectively, $t(14) = 1.68$, $p = .12$. The associative strength between central object detail and peripheral detail categories was 34.33 ($SD = 14.97$) for the negative slides and 37.34 ($SD = 18.14$) for the neutral slides, $t(14) < 1$, $p > .40$. The strengths of association between the central and peripheral detail categories were 40.17 ($SD = 21.14$) and 43.09 ($SD = 22.77$) for the negative and neutral slides, respectively, $t(14) < 1$, $p > .30$.

The associative strength of the detail categories with the theme of the slide demonstrated a comparable pattern for both negative and neutral slides. For the negative slides, the central object detail category was more strongly related to the slides' theme than were the central detail

category, t (19) = 5.39, $p < .001$, and the peripheral detail category, t (19) = 24.27, $p < .001$, means being 93.83 (*SD* = 5.57), 77.10 (*SD* = 13.41) and 26.18 (10.31), respectively. The central detail category was also significantly more associated to the theme of the slide than the peripheral detail category, t (19) = 13.50, $p < .001$. This pattern of associative strength seems to correspond with Bauml's (1998) categorization of strongly, moderately (strong), and weakly associated exemplars. For the neutral slides, the central object detail category was more strongly related to the slide theme than the central detail category, t (19) = 6.65, $p < .001$, and the peripheral detail category, t (19) = 5.59, $p < .001$, means being 74.92 (*SD* = 14.14), 54.77 (*SD* = 18.15) and 46.10 (16.37), respectively. However, the central detail category was not significantly more associated to the theme of the slide than the peripheral detail category, t (19) = 1.41, p = .18, although ratings were in the anticipated direction. These associations are less strong than those of the negative slides. The patterns of associative strengths in the negative and neutral slides appear to be in accordance with the patterns of recall usually observed in negative and neutral slides in the previous literature (e.g., Christianson, 1992).

The negative and neutral slides were given the same slide titles in order to minimize between-group differences concerning the stimulus material. Therefore, compared to experiment 1, the negative slides had somewhat different titles. Thus, the slide titles for both the negative and neutral slides were: Together, Outside, and Metro. For each slide, the central object category, central detail category, and peripheral detail category had specific names.[2]

Retrieval practice booklets. For this experiment, standardized retrieval practice booklets were constructed, in which participants had to write down their answers to the retrieval practice questions. Each page contained the slide title, the name of the central object category, and a question that asked for a particular detail from the central object. Two sets of retrieval practice

questions (RP-set) were constructed, and each set functioned as the retrieval practice-set for half of the participants (between-subjects counterbalancing). These RP-sets were matched on the number of details and on their association with the central object category as a whole. For the negative slides, there were 14 details in RP-set 1 and 16 details in RP-set 2. For the neutral slides, there were 16 details in RP-set 1 and 17 details in RP-set 2. Retrieval practice questions were tested in a pilot study (N = 10) to make sure that the questions were unambiguous and elicited the correct details. Participants viewed the slides and were then asked to answer the retrieval practice questions. The results of the pilot study demonstrated that the questions elicited the answers that were expected by the experimenters. Based on the suggestions of pilot participants about the phrasing of the questions, some questions were slightly rephrased.

During the retrieval practice phase, each participant was instructed to read the questions carefully and answer them with the central object details that they remembered. They were also encouraged not to guess. Participants had 45 s to answer each question in the first retrieval practice episode. In the second and third episode, participants were given 30 s to answer each retrieval practice question.

Distracter task. This was exactly the same task as in experiment 1. The alternative to the retrieval practice phase for the control participants was again the Raven task.

Test booklets. The test booklets were similar to those in Experiment 1 with one exception. Apart from the slide title, participants were also given the specific names of the central object category, central detail category, and the peripheral detail category. The order of slides and categories was counterbalanced. Participants were instructed to write down all of the details that they could remember in the order of the test booklet. They were also told that they were not

allowed to go back and forth within the booklet during their recall. Care was taken that the participants followed this instruction.

Procedure

With some minor modifications, the procedure was similar to that of Experiment 1. First, participants were tested in small groups (maximum of 5 persons), with each person sitting in a cubicle with a computer. Control and retrieval practice participants were tested in separate sessions. The majority of the instructions were given in written form via the computer. Before each phase of the experiment began, the experimenter ensured that all participants understood the instructions. Second, the slides were presented for 5 s.

Scoring

Cued recall data were scored by BH (c.f., inter rater reliability in experiment 1) who was blind as to whether or not participants had engaged in retrieval practice.

Design

The present study involved a 2 retrieval practice (yes vs. no) x 2 valence (negative vs. neutral) x 2 RP-set (set 1 vs. set 2) x 4 detail (practiced central object vs. unpracticed central object vs. unpracticed central vs. unpracticed peripheral) mixed design.

Results and Discussion

Where relevant, raw data were again converted into proportions based on the total number of details in the visual seen as present in the method section of this experiment 2.

The mean proportion of correctly recalled central object details in the retrieval practice phase for the retrieval practice participants was 69% (*SD* = 13.38). The mean number of reported unpracticed central object, central, and peripheral details in the retrieval practice phase was .57 (*SD* = .76). The mean number of commission errors during the retrieval practice phase was 2.47

(*SD* = 1.20).

Table 2 presents the relevant means and standard errors for the proportions of correctly recalled details and the numbers of commission errors for the different detail categories obtained during the test phase across the 4 groups. The 2 Retrieval Practice (yes vs. no) x 2 Valence (negative vs. neutral) x 2 RP-set (set 1 vs. set 2) x 4 Detail (practiced central object vs. unpracticed central object vs. unpracticed central vs. unpracticed peripheral) mixed ANOVA yielded a main effect for detail, F (3, 111) = 99.66, $p < .001$, that was qualified by a significant Detail x Retrieval Practice interaction, F (3, 111) = 13.06, $p < .001$. Follow-up independent samples *t*-tests demonstrated a significant retrieval practice effect in that the practiced central object details were significantly better recalled in the retrieval practice groups than in the control groups, t (117) = 5.40, $p < .001$, whereas no between-groups differences emerged in all other unpracticed detail categories, all *t*'s (117) < 1.

There was a main effect of valence, F (1, 111) = 8.97, $p = .003$, that was qualified by a borderline significant Detail x Valence interaction, F (3, 111) = 2.49, $p = .06$. Follow-up independent samples *t*-tests demonstrated that peripheral details from neutral slides were better recalled than those of negative slides, t (117) = 5.64, $p < .001$. No between-group differences emerged in the other practiced and unpracticed detail categories, all *t*'s (117) < 1. Finally, there was a Detail x RP-set interaction, F (3, 111) = 10.80, $p < .001$. Follow-up independent samples *t*-tests showed better recall in set 1 for central object details, t (117) = 3.85, $p < .001$, and for the unpracticed peripheral details, t (117) = 1.96, $p = .05$, but not in the unpracticed central object and central details, *t*'s (117) < 1. Furthermore, all other interaction effects, including those with RP-set as a factor, were non significant, all *F*'s (3, 111) < 1.

Looking at the commission errors, the 2 Retrieval Practice (yes vs. no) x 2 Valence

(negative vs. neutral) x 4 Detail (practiced central object vs. unpracticed central object vs. unpracticed central vs. unpracticed peripheral) mixed ANOVA showed a main effect for detail, F (3, 115) = 23.44, $p < .001$. Follow-up paired samples t-tests demonstrated that participants made more commission errors for the unpracticed central detail and peripheral detail categories as compared to the central object details (irrespective of being practiced or unpracticed), t (118) = 7.74, $p < .001$. There was also a main effect of retrieval practice, F (1, 115) = 4.74, $p = .03$, indicating that participants in the retrieval practice group made more commission errors than participants in the control group. However, no significant interaction effects were obtained, all F's (1, 115) < 1.

Taken together, although the data from experiment 2 did show a retrieval practice effect, we again failed to find an undermining effect of retrieval practice on correct recall of unpracticed details. In other words, there was no evidence for retrieval-induced forgetting, thus replicating the null results of experiment 1. Such an effect was absent not only for negative but also for neutral slides. Retrieval practice did induce more commission errors, though the present data did not reveal this to be specific to unpracticed detail categories. Compared to experiment 1, the mean proportion of correctly recalled details in the retrieval practice phase in this experiment was considerably higher. However, even with this higher level of correct retrieval, we still found no reduction in correct recall for the unpracticed detail categories.

In sum, experiment 2 replicated the failure to find retrieval-induced forgetting effects from experiment 1 after controlling even more thoroughly for the role of integration and competition. The results of experiment 2 also demonstrated that this failure to find retrieval-induced forgetting was not dependent on the negative valence of the stimulus material, as it was replicated with neutral slides. Finally, experiment 2 extended experiment 1 showing more

commission errors following retrieval practice of central details.

General Discussion

The aim of the present experiments was to investigate whether recall of unrehearsed details of emotional slides is poorer when other aspects of those same slides have been repeatedly retrieved. None of our 2 experiments demonstrated that repeated retrieval of a subset of details significantly undermines correct recall of unrehearsed details in this way. Thus, with our set of ecologically more valid stimulus material, we failed to obtain the standard retrieval-induced forgetting effect reported in the literature (e.g., Anderson et al., 1994; Barnier et al., 2004; MacLeod, 2002). However, experiment 2 did demonstrate that repeated retrieval of central object details elicited more *commission errors* for practiced and unpracticed details in both negative and neutral slides. Conversely, experiment 1 revealed that retrieval practice of peripheral details only enhanced memory for these details. Correct recall of unpracticed details was not affected. Neither was it the case that retrieval practice resulted in heightened levels of commission errors. Taken together, the present data suggest that for neutral and emotional scene material, repeated retrieval of central object details provokes commission errors for practiced and unpracticed details. At the same time, there is no support for the hypothesis that correct recall of unpracticed details would be impaired (e.g., Anderson et al., 1994; Levy & Anderson, 2002; MacLeod, 2002).

To reassure ourselves about the validity of our inability to show that with emotionally negative slides repeated retrieval did not impair correct recall of unpracticed details, we took two relevant boundary conditions into account. First, retrieval-induced forgetting effects are unlikely to be found when practiced and unpracticed exemplars are integrated at encoding (see Anderson & McCulloch, 1999). Consequently, to minimize possible integration effects at encoding, an

incidental study phase was administered in both experiments. In addition, to address the concern that negative slides may elicit higher levels of integration by virtue of their valence, experiment 2 included a neutral control condition. Furthermore, we changed the interview-form of the retrieval practice procedure in experiment 1 to a written retrieval practice procedure that was in line with the previous literature. It is interesting to note that there is some evidence that a high degree of integration between practiced and unpracticed information induces considerable recall improvement, even of the unpracticed information (Quinn, Hugenberg, & Bodenhausen, 2004). However, our data did not indicate enhanced memory for details in the unpracticed categories, thus providing further support for our view that integration did not play an important role.

The second boundary condition addressed in the present experiments concerned the amount of competition between practiced and unpracticed material. According to Anderson's (2003) account, when unpracticed exemplars are weakly related to the category cue, there is no need to suppress unpracticed exemplars simply because there is no competition between practiced and unpracticed information. Thus, recall of unpracticed exemplars will be unaffected. In experiment 1, we controlled for this by letting participants practice the peripheral details of the slides, leaving the central details as highly competitive unpracticed details. In experiment 2, we further controlled for competition by obtaining relevant associative ratings. Ratings of associative strength with the themes of the slides were strong for the central object detail category and moderately strong for the central detail category. Thus, the absence of a retrieval-induced forgetting effect for the central (object) detail category in both experiments is unlikely to be explicable in terms of weak associative strength of these categories (Bäuml, 1998).

In summary, factors such as a high degree of integration and/or a lack of competition between practiced and unpracticed information seem unlikely to account for the present failure to

obtain standard retrieval-induced forgetting effects. Furthermore, a lack of retrieval-induced forgetting in our experiments cannot simply be due to a lack of retrieval practice effects as these were present in both experiments.

One alternative explanation for our findings concerns the manner in which the stimuli have been presented. In the typical retrieval-induced forgetting paradigm (e.g., Anderson et al., 1994), study trials are presented separately in a series of category-exemplar pairs, whereas the presentation of category cue – exemplars in the present study was necessarily simultaneous due to the nature of the material. This, together with an incidental learning instruction, may have made category cue – exemplar associations (e.g., from the negative slide Metro: Attacker – blue jumper) less prominent during both study and retrieval practice. The forming of such (episodic) cue – exemplar associations at study, as is the case with serial presentation, may be crucial for the retrieval-induced forgetting effect to emerge (see Perfect et al.'s, 2004 discussion of *transfer appropriate forgetting* and Racsmány & Conway's, 2006 discussion of *episodic inhibition*). That is, during the retrieval practice phase a stronger pattern of associative strength may become established between some exemplars and the retrieval cue, relative to the study phase, and this may be responsible for occurrence of retrieval-induced forgetting (Perfect et al., 2004). Because such explicit (episodic) associations were not formed during study, there may not have been a chance to strengthen these associations during retrieval practice relative to the study phase in the present studies.

Overall, the present failure to obtain typical retrieval-induced forgetting in 2 experiments leads us to conclude that this effect cannot easily be generalized to complex visual (emotional) scenes. The implication may be that inhibitory phenomena such as retrieval-induced forgetting do not help to explain forgetting of stimulus material that more closely resembles real life

situations, as opposed to less complex stimuli such as category-exemplar pairs. Of course, retrieval-induced forgetting has previously been found for complex materials, including slides (e.g., MacLeod, 2002; Shaw et al., 1995) and autobiographical memories (e.g., Barnier et al., 2004; Wessel & Hauer, 2006). Yet, it should be noted that these studies allowed for explicit encoding of retrieval cue – target associations. If, indeed, such encoding is crucial for interference between competitors and thus for retrieval-induced forgetting to occur (Perfect et al., 2004; Racsmány & Conway, 2006, see also Camp, Pecher, & Schmidt, 2005), the class of real-life situations in which retrieval-induced forgetting could play a role becomes limited at best. Future research should be conducted to further explore this issue.

The finding that repeated retrieval of central object details elicited more commission errors for practiced and unpracticed details in experiment 2 concurs with work demonstrating that extensive repeated retrieval per se increases numbers of commission errors (e.g., Henkel, 2004; Merckelbach, Zeles, van Bergen, & Giesbrecht, in press; Schwartz et al., 1998), and that repeated retrieval of central details induces more commission errors in peripheral details (Heuer & Reisberg, 1990). This pattern of results may be explained in terms of relaxation of response criteria due to repeated retrieval attempts (e.g., Schwartz et al., 1998). It may also be explained in terms of attentional narrowing, which is a proposed side-effect of repeated retrieval of superiorly encoded central details and which may provoke commission errors for poorly encoded peripheral details (e.g., Candel, Merckelbach, & Zandbergen, 2003; Heuer & Reisberg, 1990). With this in mind, it is understandable that in experiment 2 retrieval practice of peripheral details did not result in more commission errors. After all, the unpracticed central details were better encoded and therefore less sensitive to possible undermining effects of repeated retrieval. Our results concerning commission errors have straightforward implications for the field of eyewitness

psychology. They complement previous research indicating that repetitive interviews about negative emotional situations, such as a robbery or a car accident, can increase the number of commission errors and promotes the possible formation of false memories (e.g., Bornstein et al., 1998; Roediger, Jacoby, & McDermott, 1996).

Taken together, the present experiments relied on visual emotional material to examine whether retrieval practice of particular details undermined correct recall of other details. This was intended as a first step in extending prior research in this area (e.g., MacLeod, 2002; Wessel & Hauer, 2006) to real-life distressing scenes and memories. Specifically, because different memory phenomena are said to be involved in different aspects of a single traumatic event (i.e., intrusive memory and dissociative amnesia), we employed details of complex emotional scenes rather than isolated stimuli (e.g., words or entire slides; see Anderson et al., 1994; Shaw et al., 1995). However, under these more ecologically valid circumstances, the typical retrieval-induced forgetting effect did not emerge across 2 separate experiments. As yet, there is therefore no evidence to suggest that retrieval-induced forgetting plays a role in remembering more complex visual emotional material, nor indeed in traumatic memories for that matter. Our data, however, do show that retrieval practice promotes commission errors, specifically when the central details have been repeatedly retrieved.

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Footnote

[1] Interestingly, repeated retrieval of central details did induce more commission errors in the unrehearsed peripheral details, whereas central detail memory remained unaffected. More information about this experiment can be obtained from the first author.

[2] For all negative and neutral slides, we referred to the peripheral detail category as 'other/background details'. For the negative slide 'Metro', the central object detail category was referred to as 'attacker' and the other central detail category was referred to as 'victim'. For the neutral slide 'Metro', the central object detail category was referred to as 'man' and the other central detail category was referred to as 'woman'. In the negative slide 'Together', the central object detail category was referred to as 'two men' and the other central detail category was referred to as 'injured person'. In the neutral slide 'Together', the central object detail category was referred to as 'two men' and the other central detail category was referred to as 'man behind'. In the negative slide 'Outside', the central object detail category was referred to as 'dead man' and the other central detail category was referred to as 'bystanders'. In the neutral slide 'Outside', the central object detail category was referred to as 'man' and the other central detail category was referred to as 'bystanders'.

Table 1

Experiment 1: Mean proportion of correctly recalled details and number of commission errors in the test phase (standard errors are within parentheses) of the retrieval practice (n = 29) and control (n = 30) groups.

	Unpracticed central object details	Unpracticed central details	Practiced peripheral details
Correctly recalled details			
Practice group	.53 (.03)	.43 (.03)	.27 (.02)
Control group	.53 (.03)	.46 (.03)	.18 (.02)
Commission errors			
Practice group	4.07 (.50)	2.59 (.32)	4.97 (.71)
Control group	4.97 (.49)	2.07 (.32)	3.90 (.69)

Table 2

Experiment 2: Mean proportion of correctly recalled details and number of commission errors in the test phase (standard errors are within parentheses) of the negative (n = 31) and neutral (n = 30) retrieval practice groups and the negative (n = 30) and neutral (n = 28) control groups.

	Practiced central object details	Unpracticed central object details	Unpracticed central details	Unpracticed peripheral details
Correctly recalled details				
Practice negative group	.48 (03)	.36 (.02)	.22 (.01)	.15 (.01)
Practice neutral group	.52 (.03)	.39 (.03)	.26 (.02)	.24 (.02)
Control negative group	.32 (.03)	.31 (.03)	.22 (.02)	.16 (.02)
Control neutral group	.36 (.03)	.35 (.03)	.22 (.02)	.25 (.02)
Commission errors				
Practice negative group	1.16 (.21)	.74 (.14)	1.94 (.33)	1.74 (.22)
Practice neutral group	1.37 (.29)	.80 (.18)	1.73 (.25)	2.03 (.27)
Control negative group	.77 (.16)	.87 (.20)	1.37 (.23)	1.80 (.24)
Control neutral group	.54 (.17)	.68 (.18)	1.42 (.25)	1.57 (.23)

Figure Caption

Figure 1. Stimulus material: Illustration of the type of details in the categories that participants were asked to remember. On the right hand side, the white line around the 'attacker' indicates which details were included in the central object detail category. On the left hand side, the white line around the 'victim' indicates which details belong to the central detail category. All of the other details were in the peripheral detail category.

Threat

Victim
Central detail category

Attacker
Central object detail category