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Triggering memory recovery: Effects of direct and incidental cuing

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ABSTRACT

The present study examined forgetting and recovery of narrative passages varying in emotional intensity, using what we refer to as the "dropout" method. Previous studies of this dropout procedure have used word lists as to-be-remembered material, but the present experiments used brief story vignettes with one-word titles (e.g., "Torture", "Insects"). These vignettes showed a strong dropout forgetting effect in free recall. Both text and picture cues from the vignettes eliminated the forgetting effect on a subsequent cued recall test. Vignette-related pictures in an incidental picture naming task, however, triggered little recovery of initially forgotten vignettes, as shown on a post-test. The results extend findings of large forgetting and memory recovery effects to materials that are more naturalistic than word lists. The findings also show that picture cues, which trigger strong memory recovery effects on a direct test of memory, had little effect on recovery when cues were encountered incidentally.

1. Introduction

What types of cues trigger memory recovery? Schooler, Ambadar, and Bendiksen (1997) reported case studies in which incidentally-encountered cues triggered recovery (or discovery) of memories for traumatic events (see also Cheit, 1998; Freyd, 2001). Do incidentally encountered cues trigger memory recovery?

At one time it might have seemed natural to ask about memories recovered by patients in psychotherapy (e.g., Breuer & Freud, 1893/1955; Freud, 1915/1957). More recently, however, questions about memory recovery have given way in the experimental literature to concerns about *false* memories (e.g. Kihlstrom, 2002, 2004; Loftus, 1993; Roediger & Bergman, 1998). The validity of some recovered memory accounts has been challenged on the grounds that seemingly recovered memories may actually be false memories (for a review see Lindsay & Read, 1994). A rich history of experimental evidence now underscores the susceptibility of memory to distortion and confabulation, showing that memories can be imperfect reconstructions of events (e.g., Bartlett, 1932; Munsterberg, 1908), and can be influenced by misinformation (e.g., Loftus & Palmer, 1974). Convincing evidence for false memories has been produced in a variety of ways, such as extra-list intrusions (Deese, 1959; Roediger & McDermott, 1995), imagination inflation, and failures of reality monitoring (e.g., Johnson & Raye, 1981). Illusory memories for autobiographical events were shown in the "lost in the mall" studies (e.g., Hyman, Husband, & Billings, 1995; Loftus & Pickrell, 1995; Pezdek, Finger, & Hedge, 1997). False memories have also been reported in naturalistic settings for emotional and distinctive events (e.g., Pynoos & Nader, 1989).

Far fewer studies have addressed the nature of recovered memories. One reason is the controversial nature of repression; the paucity of experimental evidence for repression has been used to undermine the authenticity of recovered memory accounts (e.g., Holmes, 1990; Kihlstrom, 2002, 2004; Roediger & Bergman, 1998). Many recovered memories have had corroborating evidence that abuse or trauma did occur and were subsequently forgotten for some period of time (e.g., Cheit, 1998;

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Freyd, 2001; Schooler et al., 1997). Erdelyi (2006) defined *repression* as a mechanism of goal-directed forgetting (see also Anderson & Green, 2001) that can be studied in the absence of trauma by decoupling defense (i.e., repressive coping) from the mechanisms employed in the service of defense. Under this theoretical framework, Erdelyi (2000) encouraged a "...synergistic integration of modern cognitive psychology and the psychodynamic tradition" (p. 70). In the present investigation we adopt a view similar to Erdelyi's (2000, 2006).

Smith and Gleaves (2006) defined a *recovered memory* as "a conscious memory of an event or an episode that one was previously unable to remember" (p. 301). The term was delineated with three criteria: "(1) the event or episode in question must have been successfully encoded, (2) memory for the encoded events must be inaccessible for a time, and (3) conscious memory must occur sometime after the period of inaccessibility" (Smith & Gleaves, 2006, p. 301). Under this framework memory recovery need not proceed from trauma, repression, or the influence of unconscious mechanisms.

An implication of laboratory studies of blocked and recovered memories is that the mechanisms that give rise to *normal* forgetting can be used to explain *abnormal* forgetting (e.g., Erdelyi, 2006; Smith & Gleaves, 2006). Experimental paradigms such as directed forgetting (e.g., Bjork, 1972), retrieval-induced forgetting (e.g., Anderson, Bjork, & Bjork, 1994, 2000; Barnier, Hung, & Conway, 2004), and the think/no-think procedure (e.g., Anderson & Green, 2001; Depue, Banich, & Curran, 2006) have contributed to a growing evidence base underscoring the role simple cognitive mechanisms (e.g., interference and inhibition) could play in goal-directed forgetting of autobiographical memories. For example, using the think/no-think procedure, Anderson and Green (2001) examined inhibition as a possible substrate of repression. They proposed that executive control processes could be recruited to suppress unwanted memories. They showed that repeated attempts to suppress information produced memory deficits in recall. Furthermore, deficits in recall became more pronounced as the number of suppression attempts increased.

Kihlstrom (2002) challenged attempts by Anderson and Green (2001) and others (e.g., Levy & Anderson, 2002) to use retrieval inhibition as an explanatory mechanism of repression. A prominent concern was that recall performance for to-be-forgotten items remained high, despite many suppression attempts. Citing Anderson and Green's data, Kihlstrom pointed out that even after 16 suppression attempts, recall of critical items remained above 70% (a 10% inhibition effect). Thus, the argument rested on whether these modest effects with innocuous verbal stimuli could be used as evidence that traumatic memories could be forgotten.

One method shown to produce dramatic forgetting was devised by Smith and colleagues (2003) to compare recovered and continuous (never forgotten) memories, and to compare accurately recovered memories with falsely recovered ones. We will refer to this method as the "dropout" procedure.[1] It called for participants to study numerous categorized word lists in an incidental learning task. Participants had three additional exposures to some of the study lists (i.e., filler lists), unaware that three of the lists (i.e., the target lists) had been surreptitiously dropped from the study set. After the interpolated tasks a free recall test was given in which participants were instructed to recall all of the list categories they could remember. To assess forgetting, recall of category names were compared for the dropout and control conditions. Participants in the control condition saw all study lists a single time at encoding and had no additional exposures to the study material. The resulting forgetting effect showed a 35% difference in recall between participants in the dropout and control conditions. Recall of critical category items was similarly poor for the dropout condition. Subsequent studies using this dropout procedure have reported forgetting effects of similar magnitudes, even for distinctive, emotional materials such as lists of curse words (Smith & Moynan, 2008; also see Gunawan & Gerkens, 2011).

Smith et al. (2003) used interference to explain the forgetting effects observed in the dropout procedure (Fig. 1). They posited that numerous re-exposures to the filler lists (but not critical lists) modulated the retrieval strength of study items. By increasing the ease with which filler lists were accessed, the resulting shift in output dominance biased retrieval against the non-rehearsed critical categories (e.g., Raaijmakers & Shiffrin, 1981). At test, the more accessible category names (i.e., those with greater output dominance) were recalled first. Forgetting was attributed to the additive effects of a downward shift in output dominance for critical lists and output interference produced by the prioritized retrieval of more easily accessible filler categories. This account is consistent with studies of output interference effects by Roediger (1973, 1978) and Rundus (1973).

Smith et al. (2003) also showed that the forgetting effects were reversible. After an initial free recall test, a final cued recall test was given in which participants were given the three critical categorized list names and asked to recall all of the category members they previously studied. When participants in the dropout condition were given the critical category names, they recalled correct category members as well as those in the control condition (see also Tulving & Psotka, 1971).

In the recovered memory debate the dynamics of memory recovery have remained largely unexplored. Smith et al. (2003) used retrieval cues to elicit recovery in their dropout paradigm. They claimed that inaccessible memories may remain available, and retrieval is dependent on appropriate cues (also see Tulving & Pearlstone, 1966; Tulving & Thompson, 1973). Consistent with this explanation, several case studies reported by Schooler et al. (1997) suggested that retrieval cuing may operate on naturally-occurring recovered (or discovered) memories. In the four cases discussed by the authors, victims of sexual abuse could access memories of their trauma after exposure to incidentally-encountered memory "triggers" corresponding to features of the original experience (e.g., off-hand remarks or movies dealing with similar subject-matter).

[1] Referring to the study paradigm as the "dropout procedure" makes no assumptions as to the mechanisms underlying the forgetting effects produced by our manipulation.

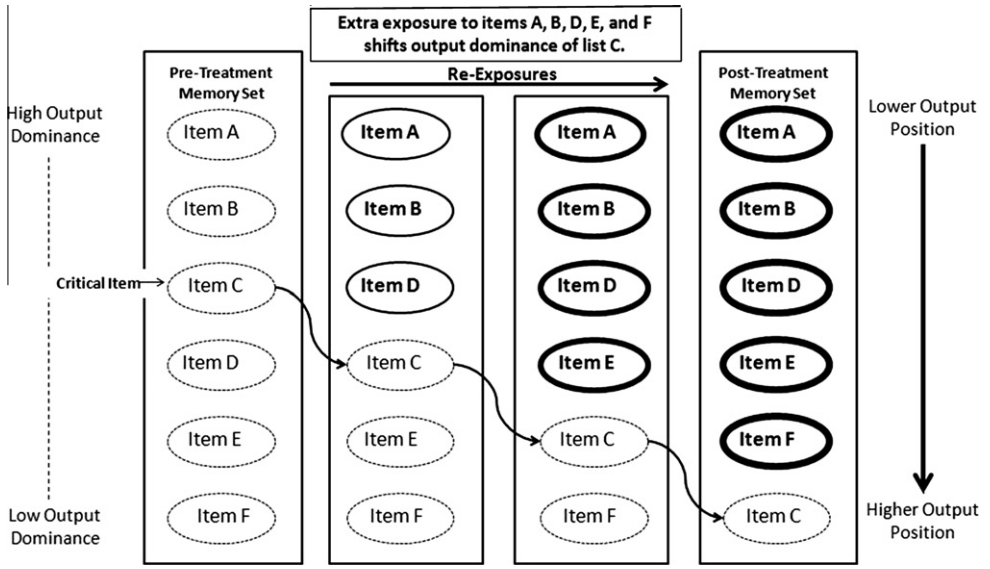

Fig. 1. Shifting output dominance. Graphic depiction of how output interference can contribute to shifts in output dominance. The thickness of the lines denotes the relative encoding strength of items in a given memory set. Critical Item C retains its pre-treatment retrieval strength through each subsequent re-exposure to the non-critical items. At the time of retrieval, the critical Item C has shifted to a position of lower output dominance whereas competing items have assumed greater ease of accessibility. *Note:* Based on a figure originally published by Smith and colleagues (2003).

What characteristics make a retrieval cue an effective memory trigger? One account attributes retention to the match between conditions at encoding and retrieval. The encoding specificity principle (Tulving & Thompson, 1973) can explain memory recovery, particularly in light of the case studies described by Schooler et al. (1997). Nairne (2002) has challenged the causal link between the encoding-retrieval overlap and performance however, suggesting that encoding specificity is but one of several factors influencing correct retrieval. Rather than the match between encoding and retrieval environments determining correct retrieval, he argued that individuals use cues to isolate target memories from those competing for retrieval (Nairne, 2002), and that the diagnostic value of a cue modulates performance and contributes to retrieval.

Studies using repeated testing show that time and successive retrieval attempts can cause recovery of previously unrecalled information even when no additional cues are provided. The terms "reminiscence" and "hypermnesia" have been used to describe the positive effects of successive testing on recall. Ballard (1913) used the term "reminiscence" to describe "the remembering again of the forgotten without re-learning" (Ballard, 1913, p. 5). His studies showed improvements in recall of poetry verses over repeated tests. Investigations by Erdelyi and Becker (1974) drew an additional distinction between reminiscence and hypermnesia. Whereas "reminiscence" refers to the recall of initially unrecalled items, "hypermnesia" was defined as a net increase in recall. This definition takes into account initially unrecalled items, and items initially recalled but omitted in later retrieval attempts due to inter-test forgetting. Hypermnesia and reminiscence are reliable memory phenomena observable in a variety of experimental settings (for a review, see Payne, 1987).

Gunawan and Gerkens (2011) reported significant hypermnesia following a dropout-induced forgetting procedure. Whereas the magnitude of their recovery effect was modest, accounting for an approximate 10% improvement in recall after three tests, the authors nonetheless found a release from dropout-induced forgetting without retrieval cuing. This finding indicates that multiple tests, as well as the passage of time may contribute to memory recovery in the form of reminiscence and hypermnesia effects.

As with the progression of research on false memories towards greater ecological validity, the present research is part of a similar progression of work on forgotten and recovered memories, which have been examined with categorized lists of words (e.g., Smith et al., 2003), and lists of emotional words (e.g., Smith & Moynan, 2008). In the present study, three experiments examined powerful forgetting effects for naturalistic materials—narrative vignettes. Replete with rich imagery and a narrative structure, these brief stories are more similar to autobiographical memories.

The present experiments also examined how forgotten material can be recovered. Smith and Moynan (2008) attributed recovery to the use of direct retrieval cues. Similar to previous studies using the dropout procedure (e.g., Smith et al., 2003), in Experiments 1 and 2 of the present study recovery was assessed with a final cued recall test in which participants were directly cued with information pertaining to the critical vignettes. In Experiment 1, the critical vignettes themselves served as memory triggers; participants were given each critical vignette and asked to recall the associated title. Would critical titles that were inaccessible on the initial free recall test nonetheless remain available in memory? We predicted that direct cuing with the vignettes would trigger recovery of the critical titles. Experiment 2 extended the study of direct cuing effects by using images in cued recall, rather than the stories themselves. These black and white drawings of everyday objects were

directly related to significant events in the four critical vignettes. Would these more subtle cues serve as effective memory triggers?

A final question regarded the role of incidentally-encountered cues in eliciting recovered memories. In Experiment 3, following the initial free recall test, participants had an interpolated task intended to incidentally expose them to the same picture cues used in Experiment 2. A final free recall test assessed recovery. Would the incidentally-encountered cues trigger recovery of the forgotten critical vignette titles, as evidenced on a final free recall test?

2. Experiment 1

Experiment 1 tested whether the dropout procedure could produce forgetting with more naturalistic materials, that is, emotionally-significant story vignettes. After reading 22 emotional and emotionally-neutral vignettes, participants in the dropout condition completed three tasks that re-exposed them to 18 of the vignettes. Participants were not told that four of the original vignettes had been dropped out of the study set. Participants in a control condition were also exposed to all 22 vignettes, after which they completed three non-verbal tasks (e.g., mazes, number search puzzles, mental rotation tasks). Forgetting was assessed via a free recall test for the critical vignette titles. To assess memory recovery, participants completed a final cued recall test in which they were provided with the critical vignettes for use as study cues.

A strong forgetting effect was expected for the dropout condition relative to the control condition. This forgetting effect was expected regardless of the emotionality of the items, as was found by Smith and Moynan (2008).

Smith et al. (2003) reported higher output positions for critical categorized lists in the dropout condition relative to the control condition. If recall deficits caused by the dropout procedure are due to the effects of shifting output dominance during the interpolated tasks and output interference accrued during the free recall test, then critical vignette titles, if they are recalled at all, should have higher (i.e., later) output positions.

Because dropout-induced forgetting effects were theorized to influence the accessibility (rather than the availability) of encoded information, a recovery effect was expected in a final cued recall test. Directly cuing participants with the critical vignettes, themselves, was expected to produce high levels of cued recall for both the dropout and control conditions.

2.1. Method

2.1.1. Participants

Sixty undergraduates from Texas A&M University participated in the experiment for credit towards the completion of their introductory psychology course. Each 60-min session included approximately 10–15 participants. Participation was voluntary, and other options were available to earn equal credit. Participants were randomly assigned to treatment conditions. The number of participants in each experimental session depended upon the random enrollment of participants. There were 30 participants in the control condition and 30 in the dropout condition.

2.1.2. Materials

Twenty-eight vignettes were sampled from amateur story compendiums on the internet. These vignettes varied both thematically and in terms of emotional intensity; half the vignettes contained unremarkable, everyday events (e.g., bike rides or insect encounters), whereas others were more emotionally-upsetting (e.g., gruesome depictions of torture or child abuse). Because of differences in story lengths, each vignette was edited to one paragraph (approximately 131 words per story), and fit in its entirety on a single screen. Care was taken to ensure that each story remained a cohesive narrative.

Each vignette had a one-word title that was a descriptive label. The titles were single nouns, derived from the theme of each vignette, but not so obvious that participants could guess the title based on the vignette.[2]

2.1.2.1. Critical vignettes. Four critical vignettes were selected, two that were emotionally evocative and two that were affectively neutral. The story "Torture" was a violent depiction of physical torture culminating in the victim's shoulder being stabbed with a hot knife, whereas "Pain" followed a young boy through his waking hours, having survived a night of repeated physical abuse from his parents. In contrast, the emotionally-neutral vignettes included a story titled "Cyclist" that chronicled a first bike-riding experience, and "Insects", which described a class demonstration by a bee-keeper.

2.1.2.2. Filler vignettes. An additional 18 filler vignettes were selected, varying in emotional valence. Nine of the vignettes were emotional and unpleasant, dealing with themes such as suicide, illness, and domestic violence. The remaining nine vignettes were affectively neutral, and included stories about sports, shopping, and wildlife encounters, and other relatively unremarkable events. Each vignette was shown in its totality on a single screen.

[2] Based on concerns raised *a posteriori* in Experiment 1, participants' ability to guess the titles of the story vignettes based only on their reading of the story was assessed. The modal likelihood of correctly guessing any of the four critical titles was 0. In a sample of 29 participants, the only title that was ever correctly guessed was "Torture" (5 participants). For the 18 filler stories, the modal likelihood of guessing the correct title was 1 out of 18.

2.1.2.3. Norming study. A norming study examined each story's emotional valence and intensity. A total of 56 undergraduates participated for credit towards the completion of their introductory psychology course. Approximately 10 participants attended each session. No participant in the norming study took part in any of the experimental studies that followed.

Twenty-eight narrative vignettes were shown for 1 min each on a large screen at the front of a classroom. Participants were cued after each story to provide their ratings. Ratings for pleasantness and arousal were based on those used by Lang, Bradley, and Cuthbert (2008). For valence, participants were instructed to rate how the story made them feel based on a 9-point scale, with 1 indicating generally unpleasant and 9 indicating generally pleasant. Arousal ratings were also based on a 9-point scale. A rating of 1 indicated that the story was extremely unarousing, and 9 indicated the story was extremely arousing. Of the 28 short stories, 22 were used in Experiment 1 (18 filler vignettes and 4 critical vignettes). For critical items, the emotional vignettes ($M = 1.59$) were rated as more unpleasant than the emotionally-neutral ones ($M = 5.74$). The emotional vignettes ($M = 5.82$) were rated as more arousing than the neutral vignettes ($M = 3.87$). The emotional fillers ($M = 2.75$) were rated significantly more unpleasant than neutral fillers ($M = 5.41$). Emotional filler vignettes ($M = 5.02$) were also rated as more arousing than neutral items ($M = 3.48$).

2.1.3. Design and procedure

Participants were randomly assigned to the control and dropout conditions. Experiment 1 used a 2×2 mixed design, where condition (control vs. dropout) was a between-subjects variable and emotionality of the vignettes (emotional vs. neutral) was manipulated within-subjects. Of the 22 vignettes, half were arousing and the other half were affectively neutral. The dependent measures were the proportion of critical vignette titles recalled on a free recall test, and the proportion of critical vignette titles recalled on a final cued recall test. In the present experiment, the procedure was modeled after previous studies using the dropout method (e.g., Smith et al., 2003; see Fig. 2).

2.1.3.1. Initial encoding. During initial encoding, participants had an incidental learning task in which each of the 22 vignettes was shown on a projection screen using PowerPoint. Presentation order was randomized, the only stipulation being that the four critical stories appear in the middle of the presentation sequence. Before each story, participants had 5 s to write down the story's title on their response form. This step ensured that story titles were well-encoded. Next, story and title were displayed together for 40 s; at the 30 s mark, a tone advised participants that they had 10 s to finish reading. After the story presentation, participants rated how well each title fit its story on a 5-point scale, with 1 indicating the story and title were not well associated, and 5 indicating they were highly associated. This procedure was repeated for each of the vignettes.

2.1.3.2. Interpolated tasks. A 30-min retention interval followed initial encoding. Participants in the control condition completed three non-verbal tasks; mazes, number search, and mental rotation. These tasks took the same time as the intervening tasks in the dropout condition.

For the dropout condition, intervening tasks re-exposed participants three times to the 18 fillers. Participants had a noun-counting task (they counted the nouns in each story), an emotionality rating task (they judged how emotional each filler story was on a 5-point scale), and a title completion task (for each story they wrote its title, given a 1-letter stem). The order of story presentation was randomized for each of the three interpolated tasks. The critical stories were never seen during the 30-min retention interval. Each task took about 10 min.

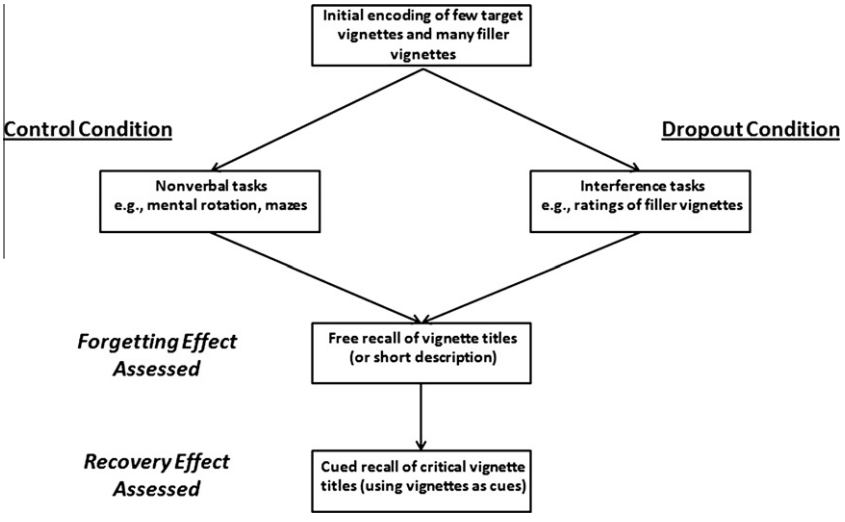

Fig. 2. A basic outline of the dropout procedure. *Note*: Based on a figure originally published in Smith and Moynan (2008).

2.1.3.3. Free recall test. For the free recall test, participants wrote down as many of the story titles as they could. Participants were urged to recall the titles of all of the stories they had seen throughout the entire experiment. Guessing was encouraged if they were unsure of a title. Participants had 5 min for this test.

2.1.3.4. Cued-recall test. A cued-recall test was given after the free recall test. Participants received a two-page handout with two of the critical stories on each page. Participants wrote down the title for each of the four critical vignettes. Guessing was encouraged if they were not certain of a vignette's title.

2.2. Results

2.2.1. Forgetting effect assessed

A 2 × 2 mixed ANOVA was computed using treatment condition (control vs. dropout) as a between-subjects factor and vignette emotionality (emotional vs. neutral) as a within-subjects factor. The proportion of critical vignette titles recalled on the free recall test was the dependent measure. As predicted, performance in the dropout condition ($M = 0.16$, $SE = 0.04$) was poorer than the control condition ($M = 0.57$, $SE = 0.04$), $F(1,57) = 40.24$, $p < .0001$, $MSE = 4.56$, partial $\eta^2 = 0.41$. Although emotional vignette titles were recalled somewhat better than neutral ones (see Table 1), the effect of emotionality was not significant, $F(1,57) = 1.48$, $p = .229$. Additionally, the interaction between treatment condition and target vignette emotionality was not significant, $F(1,57) = 0.04$, $p = .847$.

2.2.2. Output position

A between-subjects *t*-test compared the control vs. dropout conditions, using the average output percentile for recalled critical titles on the free recall test. Participants who did not recall any critical titles were excluded from the analysis; 29 participants from the control condition and 12 from the dropout condition were included. The mean output percentile in the dropout condition ($M = 0.83$, $SE = 5.23$) was greater than the control condition ($M = 0.54$, $SE = 3.73$), $t(39) = 4.31$, $p < .0001$.

2.2.3. Recovery effect assessed

A 2 × 2 mixed ANOVA was computed using treatment condition (control vs. dropout) as a between-subjects factor and vignette emotionality (emotional vs. neutral) as a within-subjects factor, using the proportion of critical vignette titles recalled on the cued recall test as the dependent measure. As illustrated in Table 2, cued recall for the control condition ($M = 0.94$, $SE = 0.03$) did not differ significantly from the dropout condition ($M = 0.93$, $SE = 0.03$), $F(1,58) = 0.16$, $p = .688$. The effect of emotionality was not significant, $F(1,58) = 0.24$, $p = .624$.

2.3. Experiment 1 discussion

In Experiment 1 we asked whether dropout-induced forgetting effects would be observed for narrative vignettes, which are more naturalistic than the categorized lists of words used in previous studies (e.g., Gunawan & Gerkens, 2011; Smith & Moynan, 2008; Smith et al., 2003). The dropout procedure produced very large deficits in recall for the dropout condition as compared to a control condition. Impairments were observed for both emotional and neutral vignettes. Although recall of emotional vignette titles was numerically higher than recall of neutral titles, the effect was not significant in Experiment 1.

The magnitude of the forgetting effect (a 41% difference) was consistent with previous experiments (e.g., Smith et al., 2003). Averaged across three experiments, Smith et al. (2003) reported a 34% difference in recall performance for emotionally-neutral categorized word lists. Smith and Moynan (2008) incorporated emotional study lists (e.g., lists of expletives, illnesses, and death-related words), and reported a 36% difference in recall performance.

Table 1
Proportion recalled in free recall of the critical vignette titles across three experiments.

	Condition	Vignette emotionality	Mean	*SE*
Experiment 1	Dropout	Emotional	0.18	0.05
		Neutral	0.13	0.05
	Control	Emotional	0.60	0.06
		Neutral	0.53	0.07
Experiment 2	Dropout	Emotional	0.23	0.08
		Neutral	0.03	0.03
	Control	Emotional	0.82	0.07
		Neutral	0.53	0.09
Experiment 3	Dropout	Emotional	0.25	0.04
		Neutral	0.12	0.03
	Control	Emotional	0.75	0.04
		Neutral	0.46	0.04

Note: Listed are the proportions of critical vignette titles recalled as a function of treatment condition and the emotionality of the narrative.

Table 2
Proportion of critical vignette titles recalled in final recall across three experiments.

	Condition	Vignette emotionality	Mean	*SE*
Experiment 1	Dropout	Emotional	0.92	0.04
		Neutral	0.93	0.03
	Control	Emotional	0.95	0.03
		Neutral	0.93	0.03
Experiment 2	Dropout	Emotional	0.63	0.08
		Neutral	0.73	0.06
	Control	Emotional	0.76	0.07
		Neutral	0.84	0.05
Experiment 3	Dropout	Emotional	0.34	0.05
		Neutral	0.23	0.04
	Control	Emotional	0.74	0.04
		Neutral	0.65	0.04

Note: Listed are the proportions of critical vignette titles recalled as a function of treatment condition and the emotionality of the narrative. In Experiments 1 and 2 the final test was cued recall; in Experiment 3, the final test was a second free recall test.

These dramatic levels of forgetting disappeared when participants were given adequate retrieval cues. Following the recall test, participants were directly cued with the four critical vignettes. Participants in both conditions recalled the titles corresponding to the vignettes. Participants in both treatment conditions recalled critical vignette titles about 93% of the time.

Experiment 1 addressed a limitation of previous studies of the dropout procedure by ensuring that recovery was for the same responses that had been forgotten. Smith and Moynan (2008) had participants recall as many category list names (e.g., *tools*) as they could on an initial free recall test. In their cued recall task, participants were given the category list names as retrieval cues for recalling category list members as possible. Deficits in recall of list names were assumed to reflect deficits in memory for entire episodes, analogous to naturalistic cases where forgetting occurs at the level of an entire event (e.g., an episode of abuse at summer camp, or the first day of high school).

3. Experiment 2

In Experiment 1, a very strong memory recovery effect was seen in the final cued recall test in which complete vignettes were given as memory cues for vignette titles. The high level of cued recall showed that even initially forgotten titles were both available in memory and accessible, given these powerful cues. Given that cued recall was near ceiling (93%), it is difficult to know whether the dropout procedure had an effect on cued recall, as it had on the free recall test. In Experiment 2, black-and-white line drawings of a central theme of each of the four critical vignettes were used as cues in the final cued recall test. Although these pictures provided diagnostic information about the vignettes, as compared to the actual vignettes, they were not as obviously related to the titles that were tested on the cued recall test. It was predicted that directly cuing memory with these pictures would produce a memory recovery effect, but that levels of cued recall would not be as high as in Experiment 1.

3.1. Method

3.1.1. Participants

A total of 39 undergraduates participated for credit towards the completion of their introductory psychology course. Study sessions had approximately 10 participants per session.

3.1.2. Materials

With few exceptions, the stimuli used in Experiment 2 were identical to those used in Experiment 1. The main difference was that on the final cued recall test four line drawings from the Snodgrass and Vanderwart (1980) norms were used as cues. Each picture reflected a theme central to its corresponding vignette. For the vignette titled "Torture", the picture cue was a knife, because in the Torture story the narrator had a hot knife stabbed into his shoulder. For the vignette titled "Pain", of the cue was a belt, which corresponded to a boy's abusive episode where he was strangled with a belt. A picture of a bee was used to cue the vignette "Insects", a story about a class trip to a beekeeper. A picture of a bicycle was used as a cue for the vignette "Riding."[3]

[3] One minor change in Experiments 2 and 3 regarded the use of the critical vignette title "Riding" as opposed to "Cyclist," which was used in Experiment 1. This change was made because pictures were used as cues to help participants recover memories of the critical story titles. Given the relative lexical similarities between the words "cyclist" and "bicycle," the alternate title "Riding" was chosen. This change ensured that participant responses in the final cued recall test would reflect their knowledge of the story, rather than their ability to simply name the image.

3.1.3. Design and procedure

Experiment 2 used a 2 × 2 mixed design. Treatment condition (dropout vs. control) was manipulated between-subjects, and target vignette emotionality (emotional vs. neutral) was manipulated within-subjects. The dependent measures were performance on a free recall test (assessing forgetting) and performance on a cued recall test (assessing recovery). Four black-and-white line drawings were given as cues on the final cued recall test.

3.2. Results

3.2.1. Forgetting effect assessed

A 2 × 2 mixed ANOVA compared the proportion of critical vignette titles recalled on the free recall test in the control condition ($M = 0.67$, $SE = 0.06$) to the dropout condition ($M = 0.15$, $SD = 0.06$) as a function of target vignette emotionality. There was a significant dropout forgetting effect, $F(1,37) = 40.25$, $p < .0001$, $MSE = 2.65$, partial $\eta^2 = 0.52$; there was a 52% difference between control and dropout conditions in free recall of the critical vignette titles (Table 1).

Recall was significantly affected by emotionality of the critical vignettes; critical emotional vignette titles ($M = 0.54$, $SE = 0.06$) were recalled more often than critical neutral titles ($M = 0.28$, $SE = 0.05$), $F(1,37) = 21.38$, $p < .0001$, $MSE = 1.42$, partial $\eta^2 = 0.37$. The interaction of target vignette emotionality by treatment condition was not significant, $F(1,57) = 0.15$, $p = .697$.

3.2.2. Output position

Participants who did not recall any critical vignette titles were excluded from the analysis of mean output percentiles of recalled titles; the resulting sample included 8 of 20 participants from the dropout condition and all 19 from the control condition. Although numerically, the mean output percentile for the dropout condition ($M = 0.64$, $SE = 0.10$) was greater than that of the control condition ($M = 0.55$, $SE = 0.05$), An analysis of the output positions of critical vignette titles (converted into output percentiles) found that the effect did not reach significance, $t(25) = 0.96$, $p = .345$.

3.2.3. Recovery effect assessed

A 2 × 2 mixed ANOVA was computed using treatment condition (control vs. dropout) as a between-subjects factor and vignette emotionality (emotional vs. neutral) as a within-subjects factor, using the proportion of critical vignette titles recalled on the cued recall test as the dependent measure. The proportion of critical vignette titles recalled in the dropout condition ($M = 0.68$, $SE = 0.06$) was not significantly different than that of the control condition ($M = 0.80$, $SE = 0.06$), $F(1,37) = 2.39$, $p = .131$. In both conditions recovery was more pronounced for the neutral vignette titles ($M = 0.84$, $SE = 0.03$) than the emotional titles ($M = 0.64$, $SE = 0.07$), as evidenced by a significant main effect of vignette emotionality, $F(1,37) = 8.47$, $p < .01$, $MSE = 0.74$, partial $\eta^2 = 0.19$ (Table 2).

A 2 × 2 × 2 mixed ANOVA assessed differences between treatment conditions (control vs. dropout), test type (initial free recall vs. final cued recall), and target vignette emotionality (emotional vs. neutral). Neither the interaction between target vignette emotionality and test type, nor between target vignette emotionality and treatment condition were significant. Additionally, the three-way interaction of these factors was not significant. However, there was a significant interaction of treatment condition and test type indicative of greater memory improvement from free to cued recall for the dropout condition compared to the control condition, $F(1,37) = 16.37$, $p < .001$, $MSE = 0.75$, partial $\eta^2 = 0.31$. Follow-up paired-samples t-tests supported this interpretation; inter-test improvement in memory performance for the dropout condition was significant ($t(19) = 7.50$, $p < .001$), whereas improvement from the initial free recall test to the final cued recall test for the control condition was only marginally significant ($t(18) = 1.96$, $p = .07$).

3.3. Experiment 2 discussion

Experiment 2 replicated the dropout-induced forgetting effect observed in Experiment 1. The dropout procedure resulted in a 52% difference in recall between the control and dropout conditions—even larger than the 41% difference reported in Experiment 1. This dropout-induced forgetting effect was as great for the emotional items as for the neutral ones, as evidenced by the non-significant interaction between condition and emotionality. The main effect of item emotionality was significant in Experiment 2, as had been predicted.

Performance on a final cued recall test showed that those in the dropout condition overcame dropout-induced forgetting effects when appropriate retrieval cues were provided at test. In Experiment 2, line drawings representing themes from the four critical vignettes served as potent memory cues, although cued recall levels were somewhat lower than those in Experiment 1.

An analysis of output positions of recalled critical vignette titles did not yield significant differences between the control and dropout conditions, although the mean output percentiles of the two conditions were consistent with the predicted pattern. In the dropout condition in Experiment 2, initial recall of critical items was poor ($M = 0.15$); it is possible that the effect of output position was not significant due to the small number of participants in the dropout condition that remained after excluding those that failed to recall any of the critical vignette titles. Whereas all of the participants from the control condition were represented in the analysis, 12 participants from the dropout condition were excluded.

The fact that participants consistently recalled the correct critical vignette titles based on viewing simple line drawings was notable. Participants appeared to obtain diagnostic information about the content of the critical vignettes—and by extension their titles—from pictures of common objects. Pictorial cues for memory recovery were used to directly cue vignette titles in Experiment 2; in Experiment 3 we asked how well would incidentally-encountered pictures trigger memory recovery?

4. Experiment 3

The dropout-induced forgetting effects in Experiments 1 and 2 were consistent with those reported in previous studies using the dropout method (e.g., Gunawan & Gerkens, 2011; Smith et al., 2003; Smith & Moynan, 2008). Directly cuing retrieval facilitated recovery of forgotten critical vignette titles in Experiments 1 and 2. As suggested in naturally-occurring cases of memory recovery (e.g., Schooler et al., 1997), incidentally-encountered cues appear to revive long-buried memories even when individuals are not engaged in active or conscious retrieval attempts.

Experiment 3 was designed to test directly the limits of memory recovery. The study design was modified to accommodate a seemingly unrelated picture-naming task interpolated between an initial memory test (assessing forgetting) and a final memory test (assessing memory recovery). For the picture-naming task, participants identified a series of black-and-white line drawings. Importantly, embedded within the collection of drawings were pictures corresponding to thematic elements from the four critical stories. In Experiment 2, these same pictures were demonstrably effective at eliciting significant memory recovery when used as direct cues on a memory test. Could these vignette-related images, now encountered incidentally, again produce memory recovery?

Half of the treatment groups were instructed that the picture-naming task might remind them of the stories they read previously, and half were given no such instruction. Combining these two manipulations, the presence (or absence) of critical vignette-related pictures and cue utilization instructions, resulted in four treatment conditions. Optimal recovery was predicted when participants were instructed to be alert to clues to forgotten items, and the critical vignette-related images were embedded in the interpolated picture-naming task. It was also predicted that even without the cue utilization instruction, the mere presence of the critical vignette-related cues in the picture naming task would elicit recovery.

Even without picture cues, it may be that those given cue utilization instructions would recover memories of critical vignettes due to continued retrieval attempts between the two recall tests. Given that participants in the instructed condition were told that some pictures may remind them of stories they had read earlier, this may have implied that there would be another memory test later in the procedure. In a fourth condition, participants completed the picture naming task without critical cues and without cue utilization instruction. In addition to serving as a control, this condition allowed us to examine recovery as a function of repeated testing. The benefits of repeated testing are well-documented (for a review see Payne, 1987), and there is evidence suggesting that repeated testing ameliorates memory deficits associated with the dropout procedure (Gunawan & Gerkens, 2011). Thus, improvement in recall over repeated testing was anticipated across treatment conditions.

4.1. Method

4.1.1. Participants

A total of 160 undergraduate students participated for credit towards completion of their introductory psychology course. There were approximately 10 participants per study session.

4.1.2. Materials

For the picture naming task, 44 black-and-white line drawings were drawn from norms published by Snodgrass and Vanderwart (1980). The same four pictures associated with the critical vignettes in Experiment 2 were again used in Experiment 3. For the conditions in which relevant cues were not included, four other images were used in their place (a smoking pipe, a clock, a carrot, and a hairbrush).

4.1.3. Design and procedure

A $2 \times 2 \times 2 \times 2$ mixed design was used in Experiment 3. Treatment condition (control vs. dropout), presence of cues (present vs. not present), and task instruction (instructed vs. not instructed) were between-subjects variables. Target vignette emotionality (emotional vs. neutral) was manipulated within-subjects. The dependent measure was the difference between the proportions of critical titles recalled in the final free recall test compared to the initial free recall test.[4]

Procedurally, Experiment 3 was identical to Experiments 1 and 2 in terms of the initial encoding, the interpolated tasks, and the first recall test. For the picture naming task, participants saw 40 line drawings of objects, and had 5 s to write down the name of each. In one condition, four drawings related to the critical vignettes were inserted in middle of the presentation sequence, with two filler pictures separating each critical picture. In the other version of the picture naming task, four filler

[4] It should be noted that using difference scores as the dependent measure to examine the main effect of study condition (dropout vs. control) on memory recovery is equivalent to using initial free recall performance and final free recall performance as separate factors (as in Experiments 1 and 2).

items were inserted in place of the pictures corresponding to the critical stories. Those in the instructed condition were told that some images may correspond to vignettes they read earlier in the experiment.

A second free recall test immediately followed the picture naming task. Participants were told to write down as many of the vignette titles as possible, with emphasis placed on recalling all of the titles seen throughout the entire experiment.

4.2. Results

4.2.1. Forgetting effect assessed

The forgetting effect was assessed with a 2×2 mixed ANOVA. Treatment condition (control vs. dropout) was a between-subjects factor, and target vignette emotionality (emotional vs. neutral) was a within-subjects factor. On the first free recall test, those in the dropout condition ($M = 0.18$, $SE = 0.03$) recalled significantly fewer critical vignette titles than those in the control condition ($M = 0.62$, $SE = 0.03$), $F(1,158) = 131.16$, $p < .0001$, $MSE = 51.20$, partial $\eta^2 = 0.74$, a 44% difference in performance between treatment conditions (Table 1). There was a significant main effect of critical vignette emotionality; emotional vignette titles ($M = 0.50$, $SE = 0.03$) were recalled more than critical neutral vignette titles ($M = 0.30$, $SE = 0.02$), $F(1,158) = 35.50$, $p < .0001$, $MSE = 3.40$, partial $\eta^2 = 0.18$. There was a significant interaction between vignette emotionality and treatment condition, $F(1,158) = 4.69$, $p = .03$, $MSE = 0.45$, partial $\eta^2 = 0.03$; forgetting was greater for emotional items than for neutral ones.

4.2.2. Output position

Participants in the dropout condition ($M = 0.77$, $SE = 0.04$) recalled critical vignette titles later than those in the control condition ($M = 0.55$, $SE = 0.02$), $t(117) = 5.66$, $p < .0001$. Participants who recalled none of the critical vignette titles were excluded from the analysis; data from 77 participants in the control condition and 42 from the dropout condition were included in the analysis.

4.2.3. Recovery effect assessed

A $2 \times 2 \times 2 \times 2$ repeated measures ANOVA was used to assess recovery; treatment condition (dropout vs. control), presence of cues in the interpolated task (present vs. absent), and cue-utilization instructions (instructed vs. not instructed) were between-subjects factors, and emotionality of target vignettes was a within-subjects factor. The dependent measure was the net increase in critical titles recalled from the first free recall to the second one (i.e., hypermnesia). Collapsed across vignette emotionality, improvements in recall performance for the control ($M = 0.10$, $SE = 0.03$) and dropout ($M = 0.09$, $SE = 0.03$) conditions were negligible,[5] $F(1,152) = 0.03$, $p = .859$. As illustrated in Fig. 3, the presence of critical-vignette related cues in the incidental picture naming task did not significantly affect recovery rates, $F(1,152) = 2.02$, $p = .157$, $MSE = 0.20$. Cue utilization instructions did not significantly aid recall, $F(1,152) = 2.02$, $p = .157$, $MSE = 0.20$.

There was a main effect of vignette emotionality (see Table 2); across treatment conditions, a greater proportion of the critical neutral vignette titles ($M = 0.15$, $SE = 0.02$) were recovered as compared to critical emotional vignette titles ($M = 0.04$, $SE = 0.03$), $F(1,152) = 12.77$, $p < .0001$, $MSE = 1.01$, partial $\eta^2 = 0.08$. In the control condition, a greater proportion of neutral critical vignette titles ($M = 0.18$, $SE = 0.04$) were recovered compared to emotional vignette titles ($M = -0.01$, $SE = 0.03$); the dropout condition recovered comparable proportions of critical emotional ($M = 0.08$, $SE = 0.04$) and neutral vignette titles ($M = 0.11$, $SE = 0.03$). This was revealed by a significant interaction between treatment condition and target vignette emotionality, $F(1,156) = 6.66$ $p < .01$, $MSE = 0.53$, partial $\eta^2 = 0.04$. Target vignette emotionality did not significantly interact with either of the interpolated task manipulations in recovery, nor did any of the three- or four-way interactions approach statistical significance.

4.3. Experiment 3 discussion

Experiment 3 replicated the dramatic dropout-induced forgetting effect observed in Experiments 1 and 2, as well as previous studies (e.g., Smith & Moynan, 2008; Smith et al., 2003). In Experiment 3 there was a 44% difference in recall of the critical vignette titles between participants in the dropout and control conditions. This result is consistent with our explanation of the dropout-induced forgetting effect, which attributes forgetting to decreased output dominance for the critical vignette titles, resulting in increased output interference on a free recall test (Fig. 2). Consistent with this explanation, the average output positions for critical vignettes were higher for participants in the dropout condition than those in the control condition.

There was a main effect of item emotionality, with more emotional items recalled better than neutral ones. This result is consistent with the results of Experiment 2, although the effect did not reach significance in Experiment 1. Across all three experiments, however, and consistent with the emotionally-enhanced memory effect (e.g., Christianson, 1992), it is clear that our emotional items are recalled better than neutral ones. Although forgetting effects in Experiments 1 and 2 were

[5] The 10% improvement in recall observed across treatment conditions could not be attributed to greater inter-test forgetting among participants in the control condition compared to those in the dropout condition, $t(158) = 0.45$, $p = .656$. Participants in the control ($M = 0.06$, $SE = 0.02$) and dropout ($M = 0.04$, $SE = 0.02$) conditions forgot a comparable proportion of initially recalled critical items on the final free recall test. Because forgetting rates were so low, we used hypermnesia as our conservative estimate of memory recovery rather than reminiscence in Experiment 3.

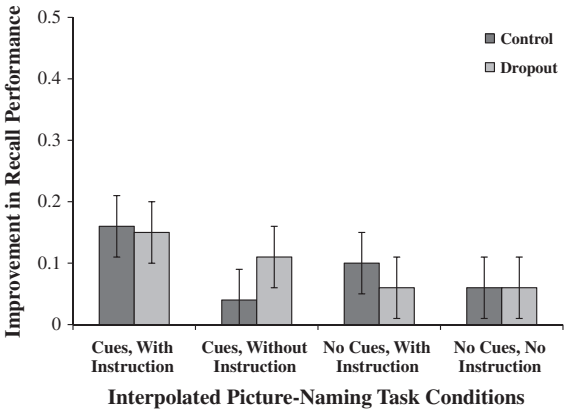

Fig. 3. Comparison between the four interpolated picture-naming task manipulations between treatment conditions in Experiment 3. Recovery was calculated as the difference in recall of the critical vignette titles when comparing recall test one and recall test two. Error bars represent ±1 standard error of the mean.

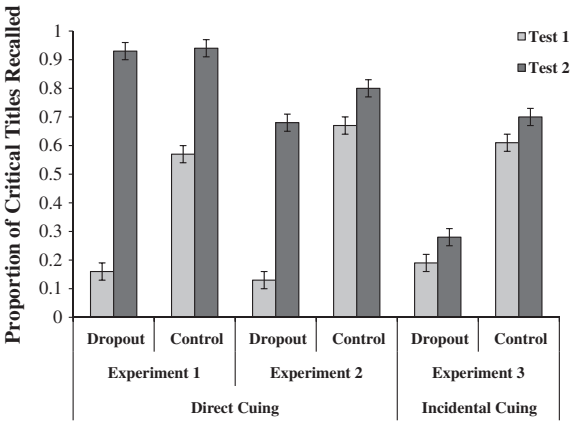

Fig. 4. A comparison of the forgetting and recovery effects for both control and dropout conditions across all three experiments. Deficits in recall for the critical vignette titles were consistent across all three experiments for the dropout condition. In Experiments 1 and 2, directly cuing participants with the critical vignettes (Experiment 1) or images related to the vignettes (Experiment 2) in a final cued recall test produced significant recovery. The dropout conditions in Experiments 1 and 2 performed as well as the control conditions. In Experiment 3, incidentally cuing participants with images embedded within a picture-naming task did not facilitate recovery. Error bars represent ±1 standard error of the mean.

equivalent for emotional and neutral items, the interaction of condition with emotionality was significant in Experiment 3, with a greater mean difference for emotional items than for neutral ones. This interaction is difficult to explain, and may well be due to the very low level of recall of neutral titles in the dropout condition of Experiment 3 ($M = 0.12$).

Across treatment conditions, the recovery rates were similar when comparing the net increase in critical vignette titles recalled in the second test, relative to the first test. While the magnitude of this recovery effect was not as impressive as the near-complete recovery of critical vignette titles in Experiment 1, some recovery was observed. Any recovery in Experiment 3 cannot be attributed to incidental cuing, because cued recall performance was no better when cues were present than when they were absent. The rates of recovery observed in Experiment 3 were consistent with those reported by Gunawan and Gerkens (2011), and simply reflect the role of repeated testing in overcoming memory blocks. Furthermore, as suggested in studies of incubated reminiscence effects (Smith & Vela, 1991), a delay between tests can cause greater recovery rates.

Null results, such as those testing incidental cuing in Experiment 3, must be evaluated carefully. One way to produce null results is to use a method that does not consistently produce a result. However, the forgetting and recovery effects demonstrated in our experiments show sizable differences in memory performance, and very large effect sizes. The mean differences in the percent initially recalled between the control and dropout conditions were 41% for Experiment 1, 54% in Experiment 2, and 42% in Experiment 3. Cohen's (1992) effect size values indicated that these effects were large[6] in Experiment 1 ($d = 1.70$), Experiment 2 ($d = 2.02$), and Experiment 3 ($d = 1.86$). In the dropout conditions, the mean differences in the

[6] Cohen (1992) characterized d values of 0.2 as small effects, 0.5 as medium effects, and 0.8 or greater as large effects.

percent initially recalled vs. the percent recalled with direct cuing (the recovery effects) were 77% in Experiment 1, and 55% in Experiment 2. Likewise, recovery effect sizes were large in the first two experiments ($d = 3.25$ in Experiment 1; $d = 1.69$ in Experiment 2), which used direct cuing. In contrast, the recovery effect in Experiment 3 showed only a 9% mean difference in recall, and the effect was only moderate ($d = 0.46$). Thus, our null results, showing no effects of incidental cuing in Experiment 3, were not due to use of an ineffective method. Related to this, we cannot attribute our null results in Experiment 3 to the use of too little statistical power. As revealed in a post hoc power analysis using the *G*Power* software package (Faul, Erdfelder, Lang, & Buchner, 2007), there was adequate power in Experiment 3 to detect a moderate recovery effect (e.g., $d = 0.46$), with $1 - \beta = 0.82$. Therefore, our null result, showing no effect of incidental cuing, was not due to insufficient statistical power. A third possible reason for a null effect is that no effect of incidental cuing exists. Our results show that we cannot reject this possibility.

5. General discussion

In three experiments, a dropout procedure produced powerful forgetting effects for narrative vignettes (see Fig. 4). The magnitudes of the forgetting effects in these experiments were quite pronounced, accounting for an approximate 46% difference in recall between control and dropout conditions, collapsed across the three experiments. Smith et al. (2003) found similar impairments for categorized lists of words, and Smith and Moynan (2008) extended these effects to violent and emotionally distinctive categorized lists (i.e., lists of expletives). In the present study, vignettes containing emotionally-arousing material were as susceptible to forgetting as affectively-neutral vignettes.

The theoretical underpinnings of the dropout-induced forgetting effect, as proposed by Smith et al. (2003), attribute forgetting to interference. Specifically, shifts in output dominance of responses in a memory set, coupled with output interference produced by strengthening competing responses, limit the accessibility of critical items in the memory set. Re-exposing participants in the dropout condition to the filler vignettes resulted in a downward shift in output position for critical vignette titles recalled on a free recall test. Participants in the control condition did not show this pattern; the probability of outputting a critical title was evenly distributed across output positions.

Repeated exposure to competing material can lead to sustained levels of forgetting. This account bears similarities to previous work by Anderson and Green (2001) who studied the role strategically-controlled inhibitory processes play in forgetting unwanted memories. They theorized that deliberate attempts at suppression could produce the levels of long-term inaccessibility characteristic of purported cases of repressed traumatic memories. The present findings suggest an alternative pathway of forgetting that could operate independently of such cognitive control mechanisms.

The present investigation found dropout-induced forgetting with emotional materials. A wealth of empirical evidence underscores the mnemonic benefits of emotionally-arousing information (e.g., Cahill & McGaugh, 1998; Christianson, 1992). Critics of the recovered memory debate have pointed to the emotionally-enhanced memory effect in discounting psychogenic amnesia of traumatic memories (e.g., Kihlstrom, 2004; McNally, 2004). In the present experiments, emotional narrative vignettes *were* generally remembered better than emotionally-neutral vignettes across conditions, consistent with the emotionally-enhanced memory effect. Emotional materials were nonetheless as susceptible as emotionally-neutral materials to the dropout-induced forgetting effect, as can be seen in the results of all three experiments. In Experiment 3, the emotional items were forgotten significantly more than neutral ones, although the interaction could be attributed to a floor effect for the neutral critical vignettes in the dropout condition. Clearly, across three experiments, we found no evidence that emotional and distinctive materials were immune to the forgetting caused by the dropout procedure.

A major finding regarded the recovery of forgotten information. As in previous studies (Smith & Moynan, 2008; Smith et al., 2003), given appropriate cues, participants in the dropout condition were able to retrieve the critical vignette titles forgotten on a previous recall test. In Experiment 1, directly cuing participants in the dropout condition with the critical vignettes greatly facilitated the recall of the vignette titles. Performance in the cued recall test for the critical vignette titles was uniformly high for both treatment conditions. However, recovery was most pronounced in the dropout condition. A comparison of performance on the initial free recall test and the final cued recall test revealed a striking difference in the proportion of critical items recalled (approximately 77%). This large recovery effect ($d = 3.25$) suggests that the dropout-induced forgetting effect operated on the level of accessibility, rather than the availability, of critical vignette titles (e.g., Tulving & Pearlstone, 1966).

Whereas Experiment 1 provided participants with highly potent retrieval cues (the critical vignettes), Experiment 2 used more subtle retrieval cues, simple black-and-white line drawings, which acted as effective memory cues. These pictures depicted common, everyday objects that corresponded to thematic elements of the four critical vignettes. When framed within the context of stories encountered earlier in the experiment, participants used these direct cues to retrieve the four critical titles. The images we used to directly cue recovery were not obviously relevant to the one-word titles themselves, but were representative of the stories from which the titles were derived. Similar to Experiment 1, an analysis of the mean difference in initial vs. final recall (55%) in Experiment 2 showed significant recovery of critical items in the dropout condition. The large recovery effect in Experiment 2 ($d = 1.69$) shows that participants were able to use the picture cues to recover memories.

The effect of directly cuing memory recovery was shown in dramatic fashion in Experiments 1 and 2. Experiment 3, however, showed no effect of incidental cuing (see Fig. 3); recovery was no different on a retest that followed incidental cues than a retest with no incidental cues. The recovery effect from incidental cues was far smaller, both in terms of the medium effect

size (d = 0.46), and the mean increase in percent recall from test 1 to test 2 (9%), than those observed in the previous experiments. More importantly, memory recovery could not be attributed to incidental cuing; the presence or absence of pictorial cues in Experiment 3 did not significantly affect performance. This result was surprising in light of the fact that Experiment 2 had shown how effective the same images were for cuing memory of forgotten targets. Thus, the results of Experiment 3 indicate that our pictorial cues, which were so effective for triggering recovery when used as direct cues in Experiment 2, did not trigger recovery when they were used as incidental cues. The modest improvement in memory performance in Experiment 3 is consistent with hypermnesia that results from using multiple memory tests. For example, Gunawan and Gerkens (2011), using the dropout method, reported similar memory improvements (approximately 10%) when they used two consecutive free recall tests without incidental cuing.

It is possible that because participants in the incidental cuing task of Experiment 3 saw so many candidate retrieval cues, it diminished the salience of the story-specific cues in the picture-naming task. This point is particularly relevant to conditions in which participants were provided with the four critical images embedded within the 40-item picture-naming tasks. If the associative value of the images, in relation to the vignettes from which they were derived, was to be strengthened (i.e., by increasing the correspondence of the image to the event), then incidental cuing might produce greater memory recovery effects.

In Experiment 3 it is unlikely that participants were deliberately searching episodic memory during the interpolated picture-naming task. Tulving (1983) described the importance of being in a "retrieval mode" to properly utilize retrieval cues (either internally-, or externally-generated). As described by Tulving, "The same stimulus reminds a person of a particular episode only when the individual's mind is in a particular state; the episodic system must be in the 'retrieval mode' before a stimulus change in the environment can serve as an effective retrieval cue to stored episodic information" (p. 46). Given this interpretation, it is easier to reconcile the relative lack of recovery in Experiment 3 with the sizeable recovery effects observed in Experiments 1 and 2, in which participants used retrieval cues intentionally to retrieve the critical vignette titles from memory. Participants in Experiment 3 were incidentally exposed to cues in an interpolated task that was not conducive to episodic retrieval. This issue was partially addressed by the inclusion of cue utilization instructions in some conditions; half of the participants were informed that some of the pictures they would see during the picture-naming task may remind them of the stories they had read earlier. The fact that cue utilization instructions and the presence of critical cues did not produce a recovery effect indicates that these conditions are not sufficient; incidental cuing does not automatically trigger memory recovery. Documented cases of recovered memories of trauma, such as those reported by Schooler et al. (1997), may therefore reflect a constellation of factors or circumstances that make recovery possible outside of the laboratory.

Whereas this set of studies advances the use of the dropout procedure beyond the purview of simple, innocuous categorized list learning, there are additional steps that could be taken towards greater ecological validity. Using this paradigm in the study of autobiographical forgetting might complement certain studies reporting false memories of autobiographical events (e.g., Loftus & Pickrell, 1995). Extending this procedure to autobiographical memory would parallel past studies examining goal-directed autobiographical forgetting using inhibitory-control mechanisms (Barnier et al., 2004).

A related issue regards the degree to which individual differences factor into memory recovery. The existence of supposed "repressors" has been endorsed by a number of studies that have approached repression as a trait (e.g., Derakshan, Eysenck, & Myers, 2007; Myers, Brewin, & Power, 1998). These studies have found that repressors are not only more susceptible to forgetting undesirable, negatively-valenced information, but that this forgetting is particularly pronounced when the information is of an autobiographical or self-referenced nature. Are there individual differences in the susceptibility to recovery as well?

6. Conclusion

In summary, in three experiments a dropout procedure was used to produce powerful forgetting of naturalistic, ecologically-valid study materials. Given adequate retrieval cues, these initial memory blocks could be overcome. However, the magnitude of memory recovery appears to be mediated by not only the quality of the retrieval cue, but also the context in which the cue is presented. In Experiment 1, directly cuing participants in the dropout condition with the critical vignettes produced nearly complete recovery. Recovery rates observed in Experiment 2 using simple black-and-white images as cues were also significant. Recovery of forgotten memories was not observed in Experiment 3, however, when retrieval cues were encountered incidentally in an interpolated picture-naming task.

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References

Anderson, M. C., Bjork, R. A., & Bjork, E. L. (1994). Remembering can cause forgetting: Retrieval dynamics in long-term memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(5), 1063–1087.

Anderson, M. C., Bjork, E. L., & Bjork, R. A. (2000). Retrieval-induced forgetting: Evidence for a recall-specific mechanism. *Psychonomic Bulletin & Review, 7*(3), 522–530.

Anderson, M. C., & Green, C. (2001). Suppressing unwanted memories by executive control. *Nature, 410*, 366–369.
Ballard, P. B. (1913). Oblivescence and reminiscence. *British Journal of Psychology (Monograph Supplements), 1*(2), 82.
Barnier, A. J., Hung, L., & Conway, M. A. (2004). Retrieval-induced forgetting of emotional and unemotional autobiographical memories. *Cognition & Emotion, 18*, 457–477.
Bartlett, F. C. (1932). *Remembering*. Cambridge, England: Cambridge University Press.
Bjork, R. A. (1972). Theoretical implications of directed forgetting. In A. W. Melton & E. Martin (Eds.), *Coding processes in human memory* (pp. 217–235). Washington, DC: Winston.
Breuer, J., & Freud, S. (1895/1955). Studies on hysteria. In J. Strachey (Ed. and Trans.). *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 2, pp. 19–305). Hogarth Press.
Cahill, L., & McGaugh, J. L. (1998). Mechanisms of emotional arousal and lasting declarative memory. *Trends in Neurosciences, 21*, 294–299.
Cheit, R. E. (1998). Consider this, skeptics of recovered memory. *Ethics & Behavior, 8*(2), 141–160.
Christianson, S. A. (1992). Emotional stress and eyewitness memory: A critical review. *Psychological Bulletin, 112*(2), 284–309.
Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155–159.
Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58*, 17–22.
Depue, B. E., Banich, M. T., & Curran, T. (2006). Suppression of emotional and nonemotional content in memory: Effects of repetition on cognitive control. *Psychological Science, 17*, 441–447.
Derakshan, N., Eysenck, M. W., & Myers, L. B. (2007). Emotional information processing in repressors: The vigilance–avoidance theory. *Cognition & Emotion, 21*(8), 1585–1614.
Erdelyi, M. H. (2000). Repression. In *Encyclopedia of psychology* (Vol. 7, pp. 69–71). Washington, DC: American Psychological Psychological Association and Oxford University Press.
Erdelyi, M. H. (2006). The unified theory of repression. *Behavioral and Brain Sciences, 29*, 499–551.
Erdelyi, M. H., & Becker, J. (1974). Hypermnesia for pictures: Incremental memory for pictures but not for words in multiple recall trials. *Cognitive Psychology, 6*, 159–171.
Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175–191.
Freud, S. (1915/1957). Repression (Trans. C. M. Baines & J. Strachey). In J. Strachey (Ed.). *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 14, pp. 146–158). Hogarth Press.
Freyd, J. J. (2001). Memory and dimensions of trauma: Terror may be 'all-too-well remembered' and betrayal buried. In J. R. Conte (Ed.), *Critical issues in child sexual abuse: Historical, legal, and psychological perspectives* (pp. 139–173). Thousand Oaks, CA: Sage Publications.
Gunawan, K., & Gerkens, D. R. (2011). The recovery of blocked memories in repeated recall tests. *British Journal of Psychology, 102*, 373–391.
Holmes, D. S. (1990). The evidence for repression: An examination of sixty years of research. In J. L. Singer (Ed.), *Repression and dissociation: Implications for personality theory, psychopathology, and health* (pp. 85–102). Chicago: University of Chicago Press.
Hyman, I. E., Husband, T. H., & Billings, F. J. (1995). False memories of childhood experiences. *Applied Cognitive Psychology, 9*, 181–197.
Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88*, 67–85.
Kihlstrom, J. F. (2002). No need for repression. *Trends in Cognitive Sciences, 6*(12), 502.
Kihlstrom, J. F. (2004). An unbalanced balancing act: Blocked, recovered, and false memories in the laboratory and clinic. *Clinical Psychology: Science and Practice, 11*, 34–41.
Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8*. University of Florida, Gainesville, FL.
Levy, B. L., & Anderson, M. C. (2002). Inhibitory processes and the control of memory retrieval. *Trends in Cognitive Sciences, 6*(7), 299–305.
Lindsay, D. S., & Read, J. D. (1994). Psychotherapy and memories of childhood sexual abuse: A cognitive perspective. *Applied Cognitive Psychology, 8*, 281–338.
Loftus, E. F. (1993). The reality of repressed memories. *The American Psychologist, 48*(5), 518–537.
Loftus, E. F., & Palmer, J. C. (1974). Reconstruction of automobile destruction: An example of the interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior, 13*, 585–589.
Loftus, E. F., & Pickrell, J. E. (1995). The formation of false memories. *Psychiatric Annals, 25*(12), 720–725.
McNally, R. J. (2004). The science and folklore of traumatic amnesia. *Clinical Psychology: Science and Practice, 11*, 29–33.
Munsterberg, H. (1908). *On the witness stand*. New York: Doubleday, Page & Company.
Myers, L. B., Brewin, C. R., & Power, M. J. (1998). Repressive coping and the directed forgetting of emotional material. *Journal of Abnormal Psychology, 107*, 141–148.
Nairne, J. S. (2002). The myth of the encoding-retrieval match. *Memory, 10*(5/6), 389–395.
Payne, D. G. (1987). Hypermnesia and reminiscence in recall: A historical and empirical review. *Psychological Bulletin, 101*, 5–27.
Pezdek, K., Finger, K., & Hedge, D. (1997). Planting false childhood memories: The role of event plausibility. *Psychological Science, 8*(6), 437–441.
Pynoos, R. S., & Nader, K. (1989). Children's memory and proximity to violence. *Journal of the American Academy of Child and Adolescent Psychiatry, 9*, 236–241.
Raaijmakers, J. G. W., & Shiffrin, R. M. (1981). Search of associative memory. *Psychological Review, 88*, 93–134.
Roediger, H. L. (1973). Inhibition in recall from cueing with recall targets. *Journal of Verbal Learning and Verbal Behavior, 12*, 644–657.
Roediger, H. L. (1978). Recall as a self-limiting process. *Memory & Cognition, 6*, 54–63.
Roediger, H. L., & Bergman, E. T. (1998). The controversy over recovered memories. *Psychology, Public Policy, & Law, 4*(4), 1091–1109.
Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 803–814.
Rundus, D. (1973). Negative effects of using list items as recall cues. *Journal of Verbal Learning and Verbal Behavior, 12*, 43–50.
Schooler, J. W., Ambadar, Z., & Bendiksen, M. A. (1997). A cognitive corroborative case study approach for investigating discovered memories of sexual abuse. In J. D. Read & D. S. Lindsay (Eds.), *Recollections of trauma: Scientific evidence and clinical practice* (pp. 379–388). New York: Plenum.
Smith, S. M., & Gleaves, D. H. (2006). Recovered memories. In M. P. Toglia, J. D. Read, D. F. Ross, D. F., & R. C. L. Lindsay (Eds.), *Handbook of eyewitness psychology* (pp. 299–320). Lawrence Erlbaum Associates.
Smith, S. M., Gleaves, D. H., Pierce, B. H., Williams, T. L., Gilliland, T. R., & Gerkens, D. R. (2003). Eliciting and comparing false and recovered memories: An experimental approach. *Applied Cognitive Psychology, 17*, 251–279.
Smith, S. M., & Moynan, S. C. (2008). Forgetting and recovering the unforgettable. *Psychological Science, 19*(5), 462–468.
Smith, S. M., & Vela, E. (1991). Incubated reminiscence effects. *Memory & Cognition, 19*(2), 168–176.
Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning & Memory, 6*, 174–215.
Tulving, E. (1983). *Elements of episodic memory*. Oxford: Clarendon Press.
Tulving, E., & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. *Journal of Verbal Learning and Verbal Behavior, 5*, 381–391.
Tulving, E., & Psotka, J. (1971). Retroactive inhibition in free recall: Inaccessibility of information available in the memory store. *Journal of Experimental Psychology, 87*, 116–124.
Tulving, E., & Thompson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80*(5), 352–373.