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Picture (im)perfect: Illusions of recognition memory produced by photographs at test

Joseph C. Wilson[1] · Deanne L. Westerman[1]

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Abstract
Photographs have been found to affect a variety of psychological judgments. For example, nonprobative but semantically related photographs may increase beliefs in the truth of general knowledge statements (Newman, Garry, Bernstein, Kantner, & Lindsay, *Psychonomic Bulletin & Review, 19*(5), 969–974, 2012; Newman et al., *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41*(5), 1337–1348, 2015). Photographs can also create illusions of memory (Cardwell, Henkel, Garry, Newman, & Foster, *Memory & Cognition*, *44*(6), 883–896, 2016; Henkel, *Applied Cognitive Psychology, 25*(1), 78–86, 2011; Henkel & Carbuto, 2008). A candidate mechanism for these effects is that a photograph increases the fluency with which a statement or an event is processed. The present study was conducted to determine whether photos at test can induce illusions of recognition memory and to test the viability of a conceptual fluency explanation of these effects. The results of the present study suggest that photographs enhance the fluency of related words (Experiment 1), that false memories can be produced by the mere presence of a related photo on a recognition memory test for words (Experiments 2 & 3), and that these effects appear to be limited to conceptually based recognition tests (Experiments 4 & 5). The results support the notion that photograph-based illusions of memory stem from the ability of related photographs to increase the speed and ease of conceptual processing.

Keywords Processing fluency · Recognition memory · Illusions of recognition memory

Can the simple act of looking at a photograph create false memories or influence beliefs about the past? A number of studies have shown that it can (e.g., Cardwell et al., 2016; Garry & Gerrie, 2005; Henkel, 2011; Lindsay, Hagen, Read, Wade, & Garry, 2004; Nash, Wade, & Brewer, 2009; Sacchi, Agnoli, & Loftus, 2007; Strange, Garry, Bernstein, & Lindsay, 2011; Wade, Garry, Read, & Lindsay, 2002). For instance, in one well-known study, Lindsay et al. (2004) asked undergraduate participants to evaluate a fabricated event, ostensibly having occurred during childhood (i.e., putting a slime toy in a teacher's desk). When the event was accompanied by an authentic class photo taken during the year that the event was to have taken place, participants were more likely to report remembering the fabricated event compared with a group that did not see a class photo.

Similar effects have been found with memory for laboratory-based events. In an experiment by Henkel (2011), participants either performed or imagined a series of behaviors, such as breaking a pencil or crushing a paper cup. On a subsequent memory test, participants were either shown photos of the completed action (e.g., a broken pencil) or a description of the action alone. Results showed that participants were more likely to report having completed the action when a photo was present than in the description-only condition (Henkel, 2011). In another recent study, participants first completed an unusual encoding task: They were shown names of unfamiliar zoo animals and simulated either giving food to the animal or taking food away. The actions were simulated by moving beans from a bag to a dish near the screen to give food and by moving beans away from the screen to the bag to take food away. A memory test followed on which participants were provided with the names of the animals either with or without a photo of the animal. Participants were asked to respond true or false as to whether they gave or took food from the target animal during the earlier phase of the experiment. The results showed that participants were more likely to respond "true" to statements that were paired with a photo of the animal (Cardwell et al., 2016). In addition, the effect of the photograph was moderated by the nature of the action; the

✉ Deanne L. Westerman
wester@binghamton.edu

1 Department of Psychology, Binghamton University, State University of New York, PO Box 6000, Binghamton, NY 13902-6000, USA

photograph made participants more likely to respond "true" when the action involved providing food, but did not affect responses when the action involved removing food. This pattern of results led the authors to hypothesize that the influence of photographs is stronger for positive events than for negative events.

The findings outlined above suggest that photographs can create false memories; however, the mechanism responsible for these effects is an open question. The fact that photographic stimuli have been shown to influence other judgments such as validity (e.g., Newman et al., 2012; Newman et al., 2015), conceptual understanding (Cardwell, Lindsay, Förster, & Garry, 2017), social evaluation (Abed, Fenn, & Pezdek, 2017), and even taste perception (Mantonakis, Cardwell, Beckett, Newman, & Garry, 2014), possibly implicates a similar mechanism underlying all these phenomena. Some researchers have suggested that enhanced fluency—the speed and ease with which an event can be processed—could account for such findings. The mere presence of a photo may call forth a range of related thoughts, ideas, and sensory evocations. This subjectively experienced cascade of semantically related mental representations and thoughts might be misattributed to prior experience due to the ease with which they come to mind (Cardwell et al., 2016). Thus, the experience of processing fluency could be a basis for concluding that the event or putative behavior occurred in the past (e.g., Jacoby & Dallas, 1981; Whittlesea, 1993). An alternative account (Nash et al., 2009) proposes that the memory-distorting effects of photos may, in part, be due to shifts in the implicit credibility criteria that participants adopt when judging how likely it is that an event occurred. Photos may be interpreted as particularly strong evidence, lowering the threshold of belief in prior occurrence.

Enhanced fluency has been used to account for recent findings that show that photographs influence the perceived validity of general knowledge claims. This effect, termed the *truthiness effect* (Newman et al., 2012; Newman et al., 2015), occurs when pictures accompany trivia-like statements. In these studies, participants are more likely to judge the statement as true compared with when the statement appears without a photo (Newman et al., 2012). It is presumed that this occurs for the same reasons that pictures elicit false memories, namely, that they lead to more fluent processing due to the activation of related mental visualizations, thoughts, and ideas. The capacity of pictures to influence judgments in a variety of domains is also supportive of the idea that a common thread of fluency underlies these phenomena.

The present study investigates the effect of photographs on a recognition memory test for words. The rationale for this approach is twofold. First, it will help to establish the generality of the effect of photographs on memory decision-making, as previous experiments have used either unconventional approaches (i.e., the Cardwell et al., 2016, study, described above, which involved testing memory for the actions related to onscreen animals), or have used manipulations that also involve suggestion (Lindsay et al., 2004; Wade et al., 2002) or imagination (e.g., Henkel, 2011). It is an open question whether such effects would be found in a more conventional recognition memory test in which numerous stimuli are shown during an encoding phase, and participants are asked to discriminate between previously seen and novel items at test. The second rationale is that it will test the credibility of a fluency explanation of the effect of photos on memory and other judgements, because the role of fluency in recognition memory has been very clearly established: Items that are relatively fluent are more likely to be classified as "old" on recognition memory tests (e.g., Jacoby & Whitehouse, 1989; Westerman, 2008; Westerman, Lloyd, & Miller, 2002; Whittlesea, 1993; Whittlesea & Williams, 2001). Therefore, if photographs enhance the fluency of related information, then participants should be more likely to judge test items more familiar ("old") if they appear with a related photograph.

It should be noted that fluency effects in recognition memory (and in evaluative psychological judgments in general) tend to fall into two broad categories, based on the way in which fluency is manipulated experimentally: perceptually based and conceptually based (Alter & Oppenheimer, 2009; Lanska, Olds, & Westerman, 2014; Lee & Labroo, 2004). Perceptually based fluency is commonly manipulated by presenting a masked repetition prime immediately preceding some of the test items (e.g., Jacoby & Whitehouse, 1989; Lanska et al., 2014). Words that are preceded by the prime are easier to process and are more likely to be classified as "old" on a recognition test. Conceptual fluency, on the other hand, refers to a feeling of subjective ease brought about by easier access to conceptual aspects of a word or situation, often through a predictive context. For example, on a recognition memory test the word *puzzles* is easier to process and is more likely to be endorsed as "old" when it appears following a predictive sentence stem ("Many people do not have the patience for jigsaw____") compared with a nonpredictive sentence stem ("As a child, I did not have a lot of time for _______"; Kurilla & Westerman, 2008; Whittlesea, 1993). As with the predictive context manipulations, photographs may establish a similar kind of semantic scaffolding that makes it easier to process a related test word.

Because photos can be conceived as essentially semantic primes of associated thoughts and mental images, they could be construed as a manipulation of conceptual fluency. Although enhanced conceptual fluency has been offered as a candidate mechanism for the influence of photographs on memory, validity, and other evaluative judgments (Cardwell et al., 2016; Newman et al., 2012; Newman et al., 2015), the effect of photographs has not been studied in a straightforward recognition memory test that involves studying a list of stimuli and discriminating old from new stimuli on a test, without instructions to imagine the to-be remembered events at either study or test (e.g., Henkel, 2011), or misleading participants to think that the events in question occurred (e.g., Lindsay et al., 2004; Wade et al., 2002). As reviewed above, the effect of processing fluency on such tasks is well documented (Jacoby & Whitehouse, 1989; Westerman et al., 2002; Whittlesea, 1993; Whittlesea & Williams, 1998), and so such an investigation has implications as to the viability of a fluency account (Jacoby & Whitehouse, 1989; Westerman et al., 2002; Whittlesea, 1993; Whittlesea & Williams, 1998). If pictures do, indeed, enhance the fluency of events, facts, or words, there should be an observable effect on recognition memory judgments. Such an effect would increase the confidence that fluency is likewise the mechanism in other domains, such as in validity judgments (e.g., Newman et al., 2012) and autobiographical memory (e.g., Lindsay et al., 2004). Contrarily, if we fail to find an influence of fluency in an item-recognition memory paradigm, this would tend to undermine a more heavily fluency-focused explanation for the phenomena in the literature, as this paradigm easily provides the most propitious conditions for the effect to manifest. A failure to find this effect may lead us to strongly consider alternative accounts regarding the mechanism (e.g., Nash et al., 2009). The present study includes five experiments that determine the effects of photographs on recognition memory judgments and explores possible mechanisms for such effects.

Experiment 1

Hypotheses about why photographs promote false memories and false beliefs center around the notion that photographs enhance the fluency of the event that is being considered (Cardwell et al., 2016). However, whether photos do, in fact, enhance processing speed and ease (the operational definition of fluency) in these paradigms has not yet been established. Therefore, Experiment 1 was conducted simply to determine whether photographs enhance the processing fluency of a related word. Participants made lexical decisions for words and nonwords. Half of the stimuli were immediately preceded[1] by a related photograph, and half were preceded by an unrelated photograph. Past work suggests that a related photograph prime should lead to faster lexical decision performance (e.g., McGlinchey-Berroth, Milberg, Verfaellie, Alexander, & Kilduff, 1993; Vanderwart, 1984). The current experiment was intended to confirm that this effect can be found using our materials.

Method

Power analysis

We estimated the number of participants needed by assuming a large effect (d = .8) in Experiment 1, which was a priming experiment and medium effects (d = .5) in the subsequent recognition memory experiments. A power analysis conducted in G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) revealed that we needed 23 participants in Experiment 1 and 54 participants in subsequent experiments to achieve a power level of .95, given a two-tailed alpha level of .05. Our Ns closely approximated these recommendations, with small deviations due to counterbalancing rotation and participant scheduling.

Participants

Twenty-four Binghamton University undergraduate students participated in exchange for partial fulfillment of course credit. Participants were tested individually.

Materials

Sixty words were selected as stimuli. The words were four to eight letters, medium frequency nouns, high in concreteness and imageability that were obtained from the MRC Database (Wilson, 1988). Thirty pronounceable nonwords were chosen that approximated the length and orthography of the words. Images depicting each of 60 words were found using a Google Image search. Some of these images contained the object alone, and others were presented within a scene/backdrop. In these latter images, the object denoting the matched word was prominent in the foreground. All, save four images, were depictions of actual real-world objects and not cartoons or drawings. This procedure is not substantively different from the one employed in past studies examining the effect of photos (Cardwell et al., 2016). Sixty stimuli in total were shown to each participant—half were words and half were nonwords. For the word trials, related photographs immediately preceded half of the words with the other half preceded by unrelated photographs that did not match the word (15 words preceded by related photos, 15 words preceded by unrelated photos). All 30 nonwords were also preceded by photographs. The words were divided into two sets of 30 words to comport with the different counterbalancing conditions that were used in upcoming experiments.

[1] In Experiment 1, the photo appeared just before the to-be judged stimuli (a prime), whereas in subsequent experiments, the photo appeared coincident with the test word. We used a sequential presentation in this initial experiment to isolate the effect of the photo on perception of the related word. We suspected that if the photo and the word were to appear on the same screen, any the priming effects of the photo may not be detectable because the more complex visual display could slow decision times overall, even if the photograph indeed made the accompanying word easier to process.

Procedure

At the start of the experimental session, participants were seated in front of a computer with a 17-in. monitor, approximately 15 inches away from the screen. They were told that a series of words would appear on the screen and were instructed to determine as quickly and accurately as possible whether each stimulus was an English word or a nonword. At the start of each trial, a photo appeared for 1 second, followed by a 250-ms screen containing a centered fixation cross and then a 250-ms blank screen. After this blank screen, the test word would be presented with the question "Is this a word?" shown at the bottom of the screen. The participants answered using a response box with buttons marked "yes" and "no." The right/left position of responses was counterbalanced. Each session consisted of 60 test trials—30 words and 30 nonwords—which were randomly intermixed. In order to encourage accurate and attentive responding, feedback as to whether the response was correct or incorrect was provided after each response.

Results and discussion

Only correct responses were analyzed (the overall average error rate was 5%). Because all nonwords were preceded by photos that are, naturally, unrelated, only word trials were examined for the following analyses. The means of each participant's median reaction time on the related versus unrelated photo trials were compared using a paired *t* test. A significance criterion of .05 was adopted for all analyses reported in this paper. There was a significant difference between the conditions, $t(23)= 4.852$, $p < .001$, $d=0.99$. As expected, reaction times were faster for words preceded by related photos ($M = 529.77$, $SD = 97.37$) compared to words that were preceded by unrelated photos ($M = 586.25$, $SD = 85.23$). These conclusions were confirmed with a Bayesian *t* test (Rouder, Speckman, Sun, Morey, & Iverson, 2009) via the calculator provided at http://pcl.missouri.edu/bayesfactor. The scaled JZS Bayes factors showed that the data were much more likely to be observed under the alternative hypothesis than the null hypothesis (scaled JZS $BF_{10} = 385.99$).

In sum, the results of Experiment 1 demonstrate that the related pictures increase the speed with which related words can be processed. This finding is an essential initial step in evaluating the viability of any fluency-based account of the role of photographs on memory.

Experiments 2

Experiment 1 established that photographs enhance the fluency with which related word are processed. The purpose of Experiment 2 was to determine whether these same photographs, if presented on a recognition test, create an illusion of recognition memory for a related word. In Experiment 2 participants studied a list of words and then took a recognition memory test in which test words were presented with or without a related photo. Past research on the effect of processing fluency on recognition memory leads to the prediction that words accompanied by photos will be more likely to be classified as "old" on the recognition memory test (Jacoby & Whitehouse, 1989; Whittlesea, 1993; Whittlesea & Williams, 1998).

Method

Participants

Fifty-eight students at Binghamton University participated in return for partial credit toward a course requirement. Participants were tested individually.

Materials and procedures

A total of 110 words were used for the study and test phases of the experiment. During the study phase, 72 words were presented; 30 were critical words and the other 42 were untested fillers. The high ratio of fillers to critical items was used to avoid possible ceiling effects on the recognition test given the high memorability of concrete words (Paivio, 1967) and to reduce the degree to which details about the study words could be recollected, which could dampen the effect of fluency on recognition (Westerman, 2001; Wolk et al., 2004). Three buffer words were also included at the beginning and end of the list to reduce primacy and recency effects. For the recognition test phase, 62 words were presented, 30 were targets (i.e., old words, which were also presented during the encoding phase) and 30 were lures (i.e., new words, which were presented only at test). The targets and lures were the same 60 words used in Experiment 1. Two of the test words were used for practice trials at the beginning of the test and were not analyzed. The images were the same as those used in Experiment 1.

Participants were tested on a computer with a 17-in. monitor, approximately 15 inches away from the screen. Participants were informed that they would see a list of words and then would take a memory test afterward, the details of which were not specified. The words on the study list appeared sequentially in the center of the screen in black font on a white background. The order of the words was randomized for each participant. Each word appeared for 2 s with a -s interstimulus interval.

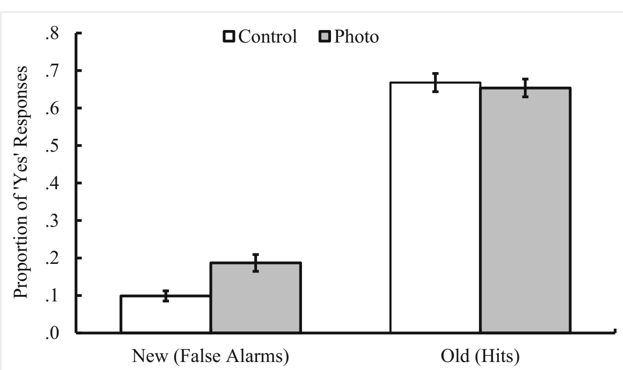
Immediately following the study list, participants were administered the recognition memory test. There were 62 test trials in total. Half of the words (15 targets, 15 lures, and 1 practice trial) were paired with a photo, and half (15 targets, 15 lures, and 1 practice trial) appeared without a photo. The test words were presented near the top of the screen. On photo trials, a photo that depicted the test word was shown below the test word. On control trials, a blank space was displayed instead. On every trial, the question "Was this word on the list?" appeared at the bottom of the screen, and participants were instructed to press *y* (for "yes") or *n* (for "no"). Words were counterbalanced such that, across participants, they had an equal likelihood of being a target or a lure and in the photo and no-photo conditions.

Results and discussion

Two subjects were excluded due to chance performance (hits equal to false alarms) on the recognition task, leaving 56 for the analyses. The results of Experiment 2 are displayed in Fig. 1. A 2 (status: old vs. new) × 2 (photo: present vs. absent) repeated-measures ANOVA was conducted on the proportion of "yes" responses. A main effect for status was found, $F(1, 55) = 434.75$, $p < .001$, $MSE = .035$, $\eta_p^2 = .89$, with subjects providing a higher proportion of "yes" responses to old words compared with new words. There was also a main effect for photo condition $F(1, 55) = 5.292$, $p = .025$, $MSE = .014$, $\eta^2 = .09$, with a higher proportion of "yes" responses observed for items that were presented with photos compared to those alone. Furthermore, there was a significant interaction between photo and status, $F(1, 55) = 16.437$, $p < .001$, $MSE = .009$, $\eta^2 = .23$, as the photo effect was stronger for new test words than for old test words. Follow-up *t* tests showed a significant effect of photos for lures, $t(55) = 4.219$, $p < .001$, $SE = .02$, $d = 0.568$, but not for targets, $t(55) = .717$, $SE = .019$, $p = .48$, $d = 0.096$. These conclusions were confirmed with Bayesian *t* tests showing that for lures the alternative hypothesis was strongly favored (JZS $BF_{1\ 0} = 238.66$), whereas for targets the null hypothesis was substantially favored (scaled JZS $BF_{0\ 1} = 5.37$).

The signal detection measures *d'* (sensitivity) and C (bias) were also computed and analyzed (see Table 1). These analyses showed lower sensitivity on the photo-present trials ($M = 1.468$, $SD = .772$) compared with the photo-absent trials ($M = 1.853$, $SD = .709$), $t(55) = 4.232$, $p < .001$, $d = .566$. An analysis of C echoed the results of the analysis of "yes" responses, with a greater tendency to respond "yes" in the photo condition, $t(55) = 2.308$, $p = .025$, $d = .308$ (Table 2).

In sum, we found that test items paired with related photos were more likely to be called "old." This is the first study, to our knowledge, showing the effect in an item-recognition test. These results are consistent with a fluency account of the effect of photos on memory and other judgments, as past studies have shown that test stimuli that are more conceptually fluent are more likely to garner positive recognition responses compared with less fluent stimuli (Lanska et al., 2014; Whittlesea, 1993). The photo effect occurred only for lures in this experiment, which is compatible with past work on fluency effects in recognition memory showing larger effects for lures than targets (Jacoby & Whitehouse, 1989; Westerman, 2008; Whittlesea & Williams, 2001). The larger effect on new items compared with old items has been interpreted within a dual-process framework of recognition



Results of Experiment 2. Error Bars represent SEMs.

Fig. 1 Results of Experiment 2. Error bars represent *SEMs*

Table 1 Signal detection analyses: Mean (*SE*) *d'* and C values for photo and no-photo conditions, Experiments 2 & 3

		Photo	No Photo
Experiment 2 (Related photo)	*d'*	1.468 (.10)*	1.85 (.09)*
	C	0.29 (.06)*	0.427 (.05)*
Experiment 3 (Unrelated photo)	*d'*	1.47 (.11)	1.50 (.11)
	C	0.32 (.06)	0.32 (.05)

*Starred comparisons represent significant differences, $p < .05$; *d'* is a measure of stimulus discrimination with higher values representing greater discrimination performance; C is a measure of response bias. Higher values represent a bias toward responding "new" and lower values represent a bias towards responding "old." A value of zero represents no bias

Table 2 Summary of key results: Effect of photograph on "yes" responses

	t value	*p*	Cohen's *d*
Experiment 2: Related photos			
N = 56			
Targets	.72	.48	.10
Lures	4.22	**<.001**	.57
Experiment 3: Unrelated photos			
N = 50			
Targets	.21	.83	.03
Lures	.31	.76	.04
Experiment 4: Verbatim instructions			
N = 54	.57	.57	.08
Experiment 5: Conceptual instructions			
N = 54	3.72	**<.001**	.51

memory (see Yonelinas, 2002, for a review) and is thought to stem from the differential influence of recollection and familiarity to judgments of old and new items. Recognition judgments made for old items are thought to rely on both recollection, memory for details about the item studied, as well as familiarity, a nonspecific sense of past experience. On the other hand, judgments of lures can only be based on familiarity. Because fluency enhances a sense of familiarity, the finding of larger effects for new items compared with old items is not surprising.

In sum, the results of Experiment 2, which show an elevated false-alarm rate for words paired with photos, are consistent with a processing fluency explanation of the data. However, other explanations are possible, as described in the next section. The next experiment is an attempt to evaluate these possible alternatives to a fluency explanation of the effects found in Experiment 2.

Experiment 3

In Experiment 2 the presence of a related photograph increased the relative tendency to call new words "old" on a recognition test. This result is consistent with the idea that photos enhance the fluency of related test words, which, in turn, elicit a false sense of familiarity for the word. However, other explanations are possible. One possibility is that the photo places additional cognitive demands on participants. For instance, participants likely scan the photo and evaluate it to some degree before deciding whether the test word is old or new. Prior research has found that a variety of cognitive tasks interpolated within a recognition test produce a more liberal response bias, similar to that found in Experiment 2. This effect, termed, *the revelation effect* (Watkins & Peyniricioglu, 1990), occurs using a wide range of cognitive tasks, including tasks that are entirely unrelated to the recognition test item (Westerman & Greene, 1998). An example of this effect would be solving the anagram HEANPELT before being asked to judge whether the word ELEPHANT was seen on the study list. The revelation effect is also commonly larger for false alarms than for hits, similar to the pattern found in Experiment 2. It is possible, then, that the effect of the photograph can be likened to a revelation effect in memory. If this is the case, the photo need not be related to the test word (e.g., Westerman & Greene, 1998). On the other hand, if the effect of the photo on recognition responses is akin to a fluency effect, it seems critical that the photograph provide a conceptual match to the test word.

A second possibility is that the visually rich and colorful photographs create a more pleasant visual experience, and this affective pleasure is interpreted as a sense of familiarity for the test word (De Vries, Holland, Chenier, Starr, & Winkielman, 2010; Monin, 2003). If so, the photos would not necessarily need to be related to the test words. An additional possibility is that the effect found in Experiment 2 is mediated by greater attention paid to the photo trials because they are more interesting and visually complex, in which case the semantic match between the photo and the test item may not be crucial.

In Experiment 3, an unrelated photograph appeared with half of the test words. If the effect of the photograph on memory operates via enhanced fluency of the test word, recognition responses should be unaffected. On the other hand, if the effect is akin to a revelation effect—a response bias produced by an interpolated cognitive task—then the effect should persist even if the photo does not match the test word (e.g., Westerman & Greene, 1998). Similarly, if the effect is due to enhanced attention or aesthetic pleasure in the photo trials, the effect may persist even if the photo is unrelated to the test word.

Method

Subjects

Fifty-one Binghamton University students participated in exchange for partial credit toward a course requirement.

Procedure

The materials, design, and procedures were identical to Experiment 2, except that the photos paired with test items were not semantically related to the test words that they accompanied. For example, the word *boot* might be paired with a picture of a lobster. The unrelated photos were obtained via a Google Image search. As in Experiment 2, the old versus new status and the picture versus no-picture status of test words were counterbalanced.

Results and discussion

One subject was excluded due to chance performance (hits equal to false alarms) on the recognition task, leaving 50 for the analyses. The results of Experiment 3 are shown in Fig. 2. A 2 (photo: present vs. absent) × 2 (status: old vs. new) repeated-measures ANOVA on the proportion of "old" responses revealed a main effect for status, $F(1, 49) = 300.74$, $p < .001$, $MSE = .038$, $\eta^2 = 0.86$, with old words called "old" more often than new words. However, there was not an effect of photo ($F < 1$) and no interaction between photo and status, ($F < 1$). A Bayesian t test confirmed the null effect for photos. Given the data, the null hypothesis was substantially more likely than the alternative hypothesis for targets (scaled JZS $BF_{01} = 6.36$) and for lures (scaled JZS $BF_{01} = 6.21$). Signal-detection analyses similarly found no significant differences in the response bias measure, C, on the photos versus control conditions, $t(49) = 0.67$, $p = .51$, nor in the discrimination measure d', $t(49) = 0.19$, $p = .85$ (see Table 1).

The null results of Experiment 3 can be contrasted with those of Experiment 2, which showed an elevated false-alarm rate when related photos appeared with test words. A supplementary analysis was conducted to compare the false recognition rate of words presented with a related and unrelated photo by conducting a 2 (photo: present vs. absent) × 2 (relatedness/experiment: related/experiment 2 vs. unrelated/ Experiment 3) mixed-factor ANOVA on the proportion of false alarms. This analysis showed no main effect for relatedness/experiment, $F(1, 104) = 1.307$, $p = .256$, $MSE = .03$, $\eta^2 = .012$; a main effect of photo condition, $F(1, 104) = 9.97$, $p = .002$, $MSE = .012$, $\eta^2 = .087$; and, most importantly for our question, an interaction between photo condition and experiment/relatedness, $F(1, 104) = 7.362$, $p = .008$, $MSE = .012$, $\eta^2 = .066$, such that the effect of photo was significantly greater in Experiment 2.[2]

Although not part of our original predictions, we note that prior research examining the impact of photos on validity ratings of trivia statements suggests that unrelated photos could create *falsiness*—a lowered belief in the trivia statements they are paired with—presumably because such photos cause disfluent processing (Newman et al., 2015). However, we did not find a parallel decrement of "yes" responses relative to the no-photo condition in Experiment 3.

In sum, in contrast to the effect of related photos, as reported in Experiment 2, unrelated photos had no discernable impact on recognition memory responses. This result suggests that the biasing effect of the photo found in Experiment 2 depends on a semantic relationship between the word and the photo, which is consistent with a processing fluency explanation.

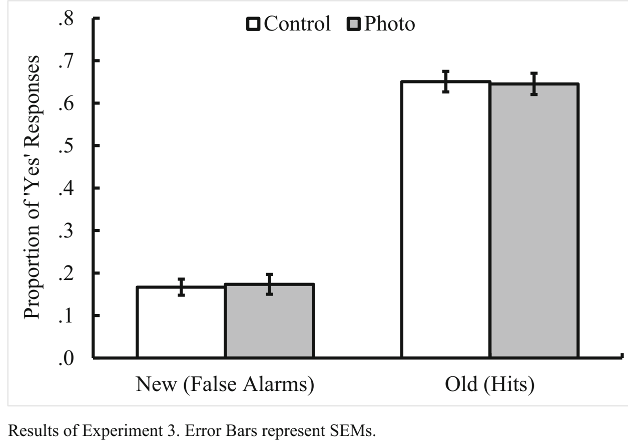


Fig. 2 Results of Experiment 3. Error bars represent *SEMs*

Experiments 4

Lindsay et al. (2004) found the presence of an authentic class photograph led to false memories for suggested events that supposedly took place during that school year. These effects occurred after repeated experimental sessions and much encouragement by the experimenters to imagine the supposed event. Could similar illusory memories be produced in a more standard laboratory session? Like the study by Lindsay et al., Experiments 4 and 5 investigated the effect of photographs on memory for fictitious events. In this case, however, the fictitious events were words that participants were supposedly exposed to under the guise of a subliminal encoding phase (Frigo, Reas, & LeCompte, 1999; Johnston, Hawley, & Elliott, 1991; Verfaellie & Cermak, 1999). Participants were told that they were exposed to a word list subliminally (in reality, only visual noise was presented) and then took a recognition memory test for words presented either with or without a photo. Participants were instructed to respond "yes" to any word that they thought that they had been exposed to on the subliminal list (standard verbatim recognition).

Method

Subjects

Fifty-four SUNY Binghamton students participated for partial credit toward a course requirement.

Procedure

Participants were told that they were in an experiment examining subliminal perception, and the researcher briefly

[2] Note that when Experiments 2 and 3 are compared, the difference between the fluency effects is due to a lower false-alarm rate in the no-photo condition in Experiments 2 versus Experiment 3, whereas the false-alarm rates in the photo conditions appear comparable in the two experiments. Given the hypothesis that related photos enhance fluency, should we not have expected to find a larger false-alarm rate in the photo condition in Experiment 2 versus Experiment 3? Not necessarily. In fact, past work on this topic strongly suggests that fluency effects in both memory and affective judgements depend on within-subjects manipulations of fluency (Dechêne, Stahl, Hansen, & Wanke, 2009; Westerman, 2008). That is, fluency effects are not found in recognition unless participants do not experience both fluent and nonfluent trials on a recognition test. Comparing the overall false-alarm rates in the photo conditions (rather than the difference between photo and no-photo conditions) in Experiments 2 and 3 amounts to a between-subjects comparison and thus does not provide a meaningful assessment of the impact of the photo on participants' impressions of the familiarity of the items that they experienced on the test. Therefore, assessing fluency effects by calculating the difference in photo versus non-photo trials *within* an a single test provides a more meaningful estimate of the effect of fluency on responses and is consistent with past theoretical and empirical results emphasizing the importance of relative versus absolute fluency (e.g., Jacoby & Dallas, 1981; Wänke, & Hansen, 2015, Westerman, 2008; Whittlesea & Williams, 1998, 2001). We note that the truthiness effect has also been found to depend on a within-subjects manipulation of photo presence (Newman et al., 2015), which is consistent with the lack of a difference in the false-alarm rates in the photo conditions of Experiments 2 and 3.

explained the concept. In order to strengthen the credibility of the cover story, participants were told that the computer programs would have to be calibrated for each participant to assure that the stimuli were truly below the level of conscious perception. As part of this calibration phase, the participants were instructed to try to read a series of words out loud in order to obtain a personalized adjustment for their individual perceptual threshold. The calibration phase consisted of 10 trials with nine words in total presented. During each calibration trial, a word would appear embedded within visual noise, except for the last trial. Each presentation of a word appeared faster than the previous until, gradually, only pure visual noise appeared on the last trial, and participants would be unable to read the latter words. In reality, no adjustments were made after the calibration phase, and the parameters of the "subliminal list" were the same for all participants. During the "subliminal list" phase, participants were shown a series of rectangular-shaped blocks of visual noise consisting of strings of letters and symbols. They were told that embedded within the visual noise, actual words were being presented subliminally and that if they concentrated, they may be able to encode the verbal information. There were a total of three different slide presentations consisting of six different visual-noise blocks. Before the blocks, an orientation cross would be presented for 500 ms. The first three blocks were presented for 15 ms, consisting of different symbols (e.g., %, #) and *X*s, followed by a 15-ms central block (e.g., lines of &s surrounded by *X*s) that varied slightly between the different slide presentations to give the impression of change. Two "postmasking" blocks of visual noise followed the central block, one 30 ms in length and the other 35 ms. When the pseudosubliminal list was over, a screen appeared, prompting the participant to call the experimenter back into the room. At this point, the experimenter reemphasized that words were indeed shown during the prior presentation and that they would now have a memory test for that "subliminally presented" verbal information.

The test phase was identical to Experiment 2, except there were no practice trials and the instructions were slightly different. Sixty words were presented, half of the time with a photo and half of the time without a photo. Participants were told that half of the words had appeared subliminally during the study list, and half had not. They were encouraged to use any sense of familiarity to guide their judgments, responding "yes" to approximately half of the trials even if they felt like they were guessing. In reality, all the test items were lures given that no actual words were presented during the pseudosubliminal list phase.

Results and discussion

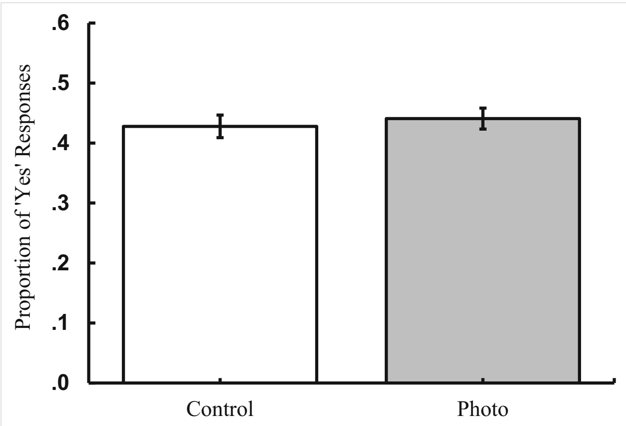
The results of Experiment 4 are displayed in Fig. 3. A paired-samples *t* test was used to analyze the proportion of "yes" responses. Contrary to our predictions, we found no significant difference between the photo-paired items (M = 0.44, SD = 0.13) and the control items (M = 0.43, SD = 0.14), $t(53) = .57$, $p = .569$, $d = .078$. A Bayesian *t* test confirmed the null effect for photos. Given the data, the null hypothesis was substantially more likely than the alternative hypothesis (scaled JZS $BF_{01} = 5.77$).

The results disconfirmed our hypothesis that we would find more "yes" responses for test words paired with the photo. This is surprising, as past work has shown robust illusions of recognition memory using other fluency manipulations. Our null effect seems unlikely to be due to insufficient power, given the larger size of our sample relative to previous studies employing the same procedure (e.g., Miller, Lloyd, & Westerman, 2008; Westerman et al., 2002; Westerman, Miller, & Lloyd, 2003).

Although we predicted some effect of photos on this test (given that participants had no real basis for their judgments), there is some precedent in the literature for attenuated effects given the specifics of this experiment. Past work has shown that conceptual fluency (e.g., manipulated through predictive sentences stems) has a stronger impact on more conceptually based recognition tests compared with perceptually based recognition tests (i.e., verbatim recognition, such as the task used in Experiment 4). Likewise, perceptual fluency (e.g., manipulated through perceptual priming) has a stronger impact on verbatim recognition tests than on more conceptually based recognition tests (Lanska et al., 2014). Because it seems reasonable to assume that the photo serves to enhance the conceptual fluency of the test word, any effect may be limited to a more conceptually based recognition test. The next experiment was identical to Experiment 4, except that test instructions were changed to emphasize more conceptual processing at test.

Experiment 5

A recent study by Lanska et al. (2014) showed that fluency effects in recognition memory depend on a match between the type of fluency that is enhanced and the type of recognition memory test. For instance, conceptual fluency manipulations, such as presenting the recognition test word as the final word of a predictive sentence stem (e.g., The stormy seas tossed the tiny BOAT), produced a larger effect on a more conceptually based recognition memory test compared with verbatim recognition tests, such as that used in Experiment 4. Using the same pseudosubliminal study phase that was used in Experiment 5, Lanska et al. found larger conceptual fluency effects when participants were asked to recognize a synonym of one of the subliminally presented words rather than a word that they allegedly saw. On the other hand, a more perceptually based manipulation of processing fluency, repetition priming, had a larger effect on recognition when participants were asked to respond "yes" to words that they purportedly



Results of Experiment 4. Error Bars represent SEMs.

Fig. 3 Results of Experiment 4. Error bars represent *SEM*s

saw. In brief, the interaction between fluency type and test type showed that verbatim recognition is more strongly affected by perceptual fluency, and more conceptually based recognition is more strongly affected by conceptual fluency.

Applying the results of Lanska et al. (2014) to the present study, we wondered if the results of Experiment 4 were due to a mismatch between the type of fluency produced by the photos and the type of fluency that participants considered relevant to the recognition decision. Specifically, given that photos are assumed to enhance the conceptual fluency of the related word, would photos influence responses on a more conceptually based recognition test? We tested this idea in Experiment 5, which was identical to Experiment 4, except for the recognition test instructions. Instead of being asked to respond "yes" to the words that they "saw" on the subliminal test, they were told that half of the test words were strongly related to a word from the subliminal list. The point of the change in instructions was to encourage participants to rely on conceptual attributes during test, which may be a context in which conceptual fluency effects are more likely to emerge.

Subjects

Fifty-four Binghamton University students participated for partial fulfillment of a course requirement.

Procedure

Experiment 5 was identical to Experiment 4, except for the test instructions given to participants. At the end of the pseudosubliminal presentation, instructions appeared on-screen, telling the subject that the test was composed of words that they did not see subliminally, but that half of the test words were strongly related to one of the words on the subliminal list. They were given the example that if the word *doctor* was presented on the subliminal list, then they might see the word *nurse* on the test. The instructions that appeared with each test word were modified accordingly. Participants were instructed to respond "yes" or "no" using a response box. As in previous experiments, half of the test words were accompanied by a related photograph and half were not.

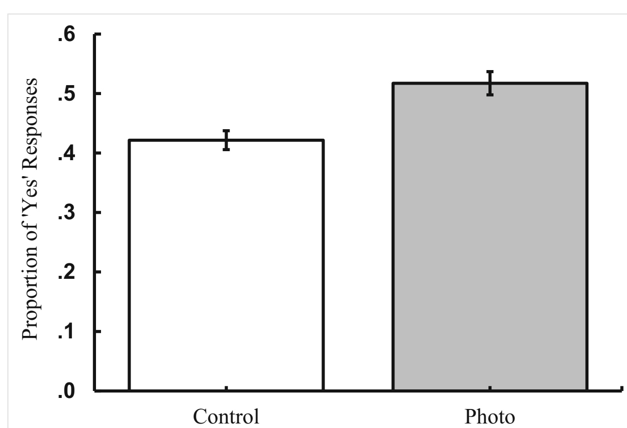
Results and discussion

The results of Experiment 5 are summarized in Fig. 4. A paired-samples *t* test revealed a significant effect of photo, $t(53) = 3.715$, $p < .001$, $d = .506$, such that words paired with photos ($M = 0.52$, $SD = 0.14$) were more likely to be judged as being strongly related to a word from the subliminal list compared with words without photos ($M = 0.42$, $SD = 0.12$). A Bayesian *t* test confirmed these conclusions (scaled JZS $BF_{1\ 0} = 52.78$).

The results are most instructive when compared with Experiment 4, which was identical except for the instructions in Experiment 5 to focus on the meaning of the word. A cross-experiment comparison of the results of Experiment 4 and 5 show a significant interaction between the effect of the photo and the test instructions, $F(1, 106) = 5.822$, $p=.018$, $MSE = .016$, $\eta^2 = 0.052$. Apparently, when semantic associations are the key basis of recognition decisions, the fluency produced by a photograph creates a sense of familiarity for the test word, whereas, when the test instructions directed participants to detect a verbatim match to what was experienced earlier, the photograph has no effect.

General discussion

The primary goal of the present study was to determine the effect of photographs on recognition memory for words. This work was motivated by studies that have shown that the mere presence of a photograph can promote the formation of false



Results of Experiment 5. Error Bars represent SEMs.

Fig. 4 Results of Experiment 5. Error bars represent *SEM*s memories for childhood events (Lindsay et al., 2004) and create a sense that false statements are true (Newman et al., 2012; Newman et al., 2015). Our results suggest that photos also affect recognition memory. New words that were presented with a related photo at test were more likely to be classified as "old" on a standard recognition test compared with words presented without a photo.

A second goal of this work was to evaluate a fluency account of the present results, and, by extension, determine the plausibility of the seemingly related effects reviewed in the introduction. Our results are consistent with a fluency-based explanation. There is a great deal of past work showing that enhanced processing fluency creates a bias to respond "old" on a recognition test. Although enhanced fluency typically elevates with both hits and false alarms, it is not uncommon to find, as we did, that new test items are more strongly affected (e.g., Jacoby & Whitehouse, 1989; Westerman, 2008; Whittlesea & Williams, 1998). One example is a study (Yang, Gallo, & Beilock, 2009) examining motor fluency effects on recognition memory for letter dyads on the keyboard, which similarly found that false alarms, but not hit rates, were inflated by the ease of processing manipulation (i.e., dyads requiring one hand to type vs. those requiring two, the easier motor action). The asymmetry of the effect for new compared with old items typically has been thought to reflect the fact that old items are more likely to be recollected, whereas responses to new items reflect primarily familiarity (see Yonelinas, 2002). Given that fluency manipulations are theorized to enhance feelings of familiarity, it is understandable that photos may have a greater effect on lures than on targets. This may be particularly likely in the current study, given the stimuli used, as concrete words are generally associated with high levels of recollection (e.g., Xiao, Zhao, Zhang, & Guo, 2012).

Experiment 3 was conducted to rule out alternative explanations for the recognition biases found in Experiment 2. One possibility was that the effect of the photo was akin to a revelation effect in memory—the positive response bias that is found when a cognitive task immediately precedes recognition test items. Critically, the revelation effect occurs even when there is no relationship between the test stimulus and the cognitive task (e.g., Westerman & Greene, 1998). If the photo creates a revelation effect, it should have occurred even when the photo was not related to the test word. That was not the case, however, as unrelated photos had no effect on recognition responses. The results of Experiment 3 also ruled out the possibility that the effect is simply due to greater attention or a more pleasant affective experience that may result when any photo accompanies a test word.

The switch to pseudosubliminal study lists in Experiments 4 and 5 served several purposes. First, it allowed us to isolate response bias, as there is no actual memory for study words affecting responses, and no possibility of recollection. Second, it served to bridge lab-based item recognition tasks and prior work on autobiographical memories for pseudoevents that supposedly took place many years earlier (Lindsay et al., 2004). Finally, the procedure allows the recognition instructions to be altered to emphasize conceptual versus perceptual attributes (without making other changes to the methods or stimuli, as would be needed with a standard recognition experiment). The results of Experiments 4 and 5 showed that the photo affected responses only when participants were instructed to select words that were strongly related to words presented subliminally (Experiment 5). However, when participants were asked to detect the actual words that they allegedly saw, the photo had no effect on their responses (Experiment 4). The fact that only a highly conceptual recognition test was impacted by the photos at test is consistent with the notion that the photo enhanced the conceptual fluency of the related test words. Past work exploring differences between perceptual and conceptual fluency has found that conceptual fluency has a stronger effect on similar conceptually based recognition tests than on verbatim recognition tests (Lanska et al., 2014). The present results suggest that photo effects are conceptual in nature, akin to predictive-context manipulations (Lanska et al., 2014; Whittlesea, 1993).

One loose thread that remains is how to reconcile the results of Experiments 2 and 4. Why did the photograph enhance false recognition in Experiment 2, but not in Experiment 4, even though the test question was exactly the same? This was an unanticipated finding, as we predicted that the fluency effect may be stronger after a pseudosubliminal encoding phase. This prediction was based on our reasoning that participants would be unable to recollect anything meaningful from the study phase (other than visual noise), which would mean that responses would be largely based on an overall sense of familiarity (and guessing). The fact that we found a null fluency effect forced us to reconsider the basis of our prediction. In doing so, we see that our initial hypothesis was probably too simplistic in that it did not fully take into account the type of fluency that is likely being enhanced by photographs. Indeed, two recent studies by Lanska and colleagues (Lanska et al., 2014; Lanska & Westerman, 2018) make the point that the various types of fluency (e.g., perceptual, conceptual, lexical) are not experienced generically. Rather, the extent to which each type of fluency affects recognition responses depends on the degree to which it is diagnostic of past experience with a stimulus. Lanska et al. (2014) compared perceptual and conceptual fluency across a number of different encoding and test conditions. The results showed that perceptual and conceptual fluency effects were comparable in size after standard intentional encoding instructions (such as those used in Experiment 2 in the present study); however, participants who were given a highly perceptual task during the encoding phase (counting the curved letters in a word) relied much more heavily on perceptual fluency at test ($d = .50$) compared with conceptual fluency ($d = .19$). Lanska et al. (2014) also used a pseudosubliminal study phase in two of their experiments. They found that the effect of conceptual fluency (manipulated by presenting test words in a predictive context) was attenuated after a pseudosubliminal encoding phase, compared with a study phase that involved actual words and standard intentional encoding conditions—a pattern similar to what is found when comparing the results of Experiment 2 with those of Experiment 4. A more recent study showed the same general effects using different fluency manipulations and different encoding tasks (Lanska & Westerman, 2018), leading the authors to propose that fluency is more likely to be interpreted as a sense of familiarity if the type of processing carried out during encoding matches the type of fluency that is manipulated at test, and the task demands (e.g., respond "yes" to a verbatim match vs. respond "yes" to a synonym) match the type of fluency that is enhanced. Returning to the present study, it is important to consider that the encoding phase of the pseudosubliminal procedure was highly perceptual in nature. Participants saw a series of meaningless visual symbols, which were flashed at them very briefly. On the other hand, in Experiment 2, participants read meaningful English words and tried to remember them. As such, the relevance of conceptual fluency to the recognition decision seems much greater in Experiment 2—which could be answered based on a conceptual match between study and test—compared with Experiment 4, in which nothing meaningful was presented during encoding. If we adopt the reasonable assumption that photos enhance conceptual fluency, the differential relevance of conceptual fluency in Experiment 2 versus Experiment 4 may explain why photographs led to false recognition in Experiment 2 (and Experiment 5), but not Experiment 4.

Another potential concern is whether demands characteristics play a role in the present results. It may be the case that subjects inferred the hypotheses of the experiments and responded, consciously or unconsciously, in accordance with these influences. We do not think that the weight of the evidence supports this interpretation, however. If that were the case, we should have found a photo effect in Experiment 4. The fact that the effect reemerged in Experiment 5, after a slight change in the test instructions, is additional evidence against a demand characteristics account, as the instruction change did nothing to inflate the relevance of the photograph to the test word. In short, the fact that the present series of experiments revealed boundary conditions for the effect of the photo on recognition that are consistent with past work on fluency effects in recognition gives more credence to a fluency account than to one premised on demand characteristics.

In summary, our study shows that false recognition of words can be induced by the mere presence of a related photograph on a recognition test. These experiments strengthen the case that photographs can enhance processing fluency of the judged event/stimulus. In addition, our results point to enhanced conceptual fluency as a likely mechanism for this effect.

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