Framing the past (and future): Effects of generic photos on autobiographical judgments

Joseph C. Wilson¹ · Deanne L. Westerman¹

Accepted: 18 December 2020 / Published online: 4 January 2021
© The Psychonomic Society, Inc. 2021

Abstract

Do the images we see every day influence how we remember our lives? Research on this matter often concerns how entire memories of events can be created or shaped through the use of doctored photographs of personal (Wade et al., *Psychonomic bulletin & review*, 9 (3), 597–603, 2002) and public events (Sacchi et al., *Applied Cognitive Psychology*, 21 (8), 1005–1022, 2007). Although this paradigm has yielded insights into false memory production, it may underestimate the extent to which photographs can bias or distort memory in a subtler manner (i.e., without the use of doctored photographs or suggestion). In Experiments 1 (N = 95) and 2 (N = 186) of the present study, we examined whether the mere presence of generic images, typical of stock photography, could influence aspects of our memories. Given the parallel between autobiographical remembering and forecasting (Berntsen & Bohn, *Memory & Cognition*, 38(3), 265–278, 2010), we also examined (Experiment 3: N=204) how such images would influence future autobiographical judgments. Specifically, three experiments investigated whether photographs would bias autobiographical judgments for either quantitative (e.g., *How many movies have you seen in the past year?*) or affective (e.g., *How enjoyable do you think your next date will be?*) aspects of events in everyday life. We found that photographs reliably influenced judgments related to quantitative aspects of autobiographical events. Moreover, though less robustly, there was an indication that these photos could bias our affective construal of such events as well. Overall, we conclude that the mere presence of generic photographs may exert an influence on the way we think about our lives to an extent previously unrecognized.

Keywords Autobiographical memory

Introduction

In a given day, we are exposed to countless photographs. Some reflect our own experiences; we take and share pictures of our day-to-day activities, create and maintain photo albums, and take “selfies,” often with the goal of preserving the memory of certain moments in our lives. We are constantly exposed to photos of our friends, families, and peers on social media, as we post our own. And of course, we are also shown a torrent of advertisements that typically contain images or photos depicting commodities and experiences. Given the pervasiveness of photographs and images in our lives, it is natural to question what effect viewing them has on our memory for the events of our lives. Because authentic photographs, such

as those we take on our smartphone cameras, depict past events, it’s reasonable to think that they may serve as useful aids in retrieval of those events, something that we may assume implicitly when we take pictures. Indeed, looking at photographs can help to increase recall for details of that event (e.g., Koutstaal, Schacter, Johnson, Angell, & Gross, 1998) and can be used to facilitate contextual reinstatement (e.g., Wilcock, Bull, & Vrij, 2007). But could there also be a disadvantage to viewing photos this way? Can photographs distort the way we think about our personal pasts by creating false memories or other illusions?

Attempts to distort beliefs about the past through outright manipulation of images could be an obvious disadvantage if photos are used in this deceptive way. Indeed, intentionally doctored photos have been found to distort beliefs about the past and memories. A classic demonstration is a study by Wade et al. (2002), wherein a photograph that was doctored to include participants in a childhood hot-air balloon ride (confirmed never to have happened) increased beliefs that this pseudo-event had taken place. Similarly, Frenda, Knowles,

✉ Joseph C. Wilson
jwilso10@binghamton.edu

¹ Department of Psychology, Binghamton University, Vestal, NY, USA

Saletan, and Loftus (2013) induced false memories of invented political events (e.g., President Obama shaking hands with then Iranian President, Mahmoud Ahmadinejad) through the presentation of altered photos purporting to depict the episode.

Other studies have looked at how the doctored photos may alter impressions of past events. Sacchi et al. (2007) showed how doctored photographs can alter memories for well-known public events, such as the 1989 Tiananmen Square incident. Italian research participants were either shown unaltered photos of these events or photos that were manipulated on several dimensions. Their findings show that the content of the photographs influenced participants' judgments about these events. For example, doctoring the Tiananmen photograph such that it depicted massive crowds of people at the scene led to inflated estimates of how many people participated (Sacchi et al., 2007; see also Nash, 2018). It is important to note that the effects of the doctored photos here are subtler in that they bias memories for events that happened, rather than inventing pseudo-memories in their entirety.

Though the use of manipulated photographs has been shown to produce powerful memory illusions, it is probably not the primary means through which such distortions may occur. What may be more insidious in terms of false memory and false belief formation are ordinary, unaltered photographs we see every day, particularly in the digital realm, if only because of the sheer ubiquity and frequency of such exposures. This concern is substantiated by several studies showing that ordinary photographs may contribute to the formation of false beliefs about the past or full-blown false memories (Cardwell, Henkel, Garry, Newman, & Foster, 2016; Strange, Garry, Bernstein & Lindsay, 2011; Lindsay, Hagen, Read, Wade, & Garry, 2004; Murphy, Loftus, Grady, Levine, & Greene, 2019; Wade, Nightingale, & Colloff, 2017). An interesting example by Lindsay et al. (2004) showed that a fabricated description of a childhood prank presented alongside an authentic class photograph produced more false memories for the pseudo-event than presenting the description of the event alone (see also Blandón-Gitlin & Gerkens, 2010).

There are perhaps two primary mechanisms that underly the influence of photographs in the manners described above. Firstly, in some cases, particularly those involving the doctoring of content depicted, photographs could be seen as relevant and credible evidence that the event actually occurred (Nash, Wade, & Brewer, 2009). Even photographs that are on their face non-probative may still be viewed as support for the claims with which they accompany. Why else would the experimenter present them? (cf. Zhang, Newman, & Schwarz, 2021) Secondly, processing fluency, specifically of a conceptual nature, has been proposed as another explanation (Nash, 2018; Newman, Garry, Bernstein, Kantner, & Lindsay, 2012; Strange et al., 2011; Wilson & Westerman, 2018). According to this account, the photograph is capable of bringing to the

fore mental images and other related associations more easily. If the photograph is paired with a prompt to remember an event or item, the ease of processing induced might be misattributed to that event having actually happened. The sense of perceived familiarity and the feeling of fluency therefore become conflated, with the outcome being an increase in false beliefs and memories.

The present study

The above findings suggest multiple ways by which photographs, both doctored and authentic, may influence perceptions of the past. The current study attempts to further fill in gaps in our knowledge regarding the effects of photographs, particularly regarding autobiographical memories. As noted elsewhere (Marsh & Rajaram, 2019), given the extent to which our lives are mediated through the photograph-rich and image-dense environment of social media and the internet more generally, it is the autobiographical component of memory that may be uniquely subject to distortion. Of the studies investigating the effects of photos on autobiographical memories, a common feature is the explicit instruction to imagine past events and to use the photos to aid memory (Blandón-Gitlin & Gerkens, 2010; Lindsay et al., 2004). Furthermore, there is also the element of time that may be playing a facilitative role, as the delay between the manipulation and the test may make it more difficult to distinguish between what was actually experienced and what was merely imagined.

Framing the past

The key question examined by the current research is whether simply presenting a generic content-related photo would influence autobiographical memory judgments without more forceful prompting, instructions to imagine the event, or the use of delays between exposure and judgments. Though there is already evidence that such photos can promote false memories for laboratory events using such a procedure (Cardwell et al., 2016; Henkel, 2011; Henkel & Carbuto, 2008; Wilson & Westerman, 2018), there is as yet no direct evidence that this low-intensity method can similarly affect memories for more naturalistic autobiographical events.

We were specifically interested in whether photos might have other, subtler influences on how we think about our personal pasts, short of the whole cloth fabrication of entire events in memory. There are several studies showing that photos may have such effects that can frame how we remember certain aspects of an event (Nash, 2018; Sacchi et al., 2007). Returning to the doctored photo evidence, we have seen that altering details of photographs depicting public events can foreground certain elements that could be

“defining” for the event under scrutiny, namely how significant it may have been (in terms of sizes of crowds in attendance) or the overall character or mood of the event (violent or peaceful). In a parallel manner, the experiments (Experiments 1 and 2) that follow also investigate how photographs can influence these types of dependent variables. Specifically, we wanted to know whether both the more quantitative (e.g., *How many people were at the last party you attended?*) and more emotional (e.g., *How pleasant was your last family dinner?*) aspects of our personal pasts could possibly be subject to photographic influence. These experiments also had a few other novel parameters: (1) only generic, non-probative photographs are used; (2) the judgments are strictly focused on the personal pasts of the participants, not on laboratory events or public events reported in the news media; and (3) no highly intensive/suggestive methods to induce memory illusions are employed. We had initially supposed that this presentation of a generic photograph may influence autobiographical judgments through the mechanism of conceptual fluency, as has been proposed in past work (e.g., Nash, 2018). The generic images we displayed along with the question could facilitate the processing of the event along the lines suggested in the content depicted, which underscored either a particular emotional valence (Positive vs. Negative) or a quantity (High vs. Low). For example, it could be easier to visualize your last family dinner as having been more pleasant if you are presented with an image depicting a contented family enjoying their dinner, as you are recalling your own. Similarly, one might find it easier to imagine having actually gone to a particularly high-turnout party if you are presented with an image of one. By way of this mechanism, a type of fluency-misattribution could occur, leading to biasing of autobiographical judgments in the direction portrayed in the generic image.

Framing the future

Analogous to the use of photos to think about past events in our lives, it is not uncommon to see photos being used as a means to make us think about or imagine our possible futures. For example, the presentation of a photograph of a vacationing family relaxing on a beach watching the sunset in a far-away destination may help us to imagine a similar getaway for our own families in the future. This is of course what many in the tourism industry strive to do in their television or magazine advertisements. A second question therefore concerns forecasting in relation to future autobiographical events. There is suggestive evidence of an overlap between the simulation of future events and the constructive processes involved in remembering past events (Schacter, 2012). Several studies have also shown that thinking about the future and remembering the past engage some of the same brain networks (Addis,

Sacchetti, Ally, Budson, & Schacter, 2009; Schacter et al., 2012; Szpunar, Watson, & McDermott, 2007), share similar underlying phenomenology (Berntsen & Bohn, 2010; D’Argembeau & Van der Linden, 2004), and are subject to similar biases (Gregg, Upadhyay, Kuntzelman, Sacchi, & Westerman, 2019; Newman, Azad, Lindsay, & Garry, 2018; Westerman, Miller, & Lloyd, 2017). Given such commonalities, there’s reason to think that the biases affecting confidence that past events occurred would also influence confidence that future events will occur. Therefore, we also examined (Experiment 3) how the same subtle manipulations that could bias the past autobiographical judgments used in Experiments 1 and 2 may similarly influence these same types of judgments when they are cast into the future.

Experiment 1

The details of public event memories have been shown to be shaped by the presentation of doctored photographs depicting those events, particularly influencing beliefs or recollections both about the prominence (of protester/crowd size) and affect/mood (of violence/peacefulness) associated with such events (Nash, 2018; Sacchi et al., 2007). The experiments that follow were informed by this approach. As with previous studies, the question of interest here was how photographs can affect perceptions of the past. However, there were key differences. Firstly, the memories/beliefs targeted in the present experiments were of a more personalized and autobiographical nature. Rather than revolving around well-known public events, our study tapped memories about everyday life. A second key difference was that the photographs were not doctored images depicting the events in question, but were non-probative photographs that, although related in content, do not specifically depict the actual autobiographic events probed. Rather, they were merely generic representations of them, as might be found in advertisements using stock images.

In Experiment 1, participants were asked a series of questions about their experiences under the pretense of a “Life Survey.” They were asked about a variety of everyday experiences (e.g., their last plane flight, the number of people at the last campus event that they attended, etc.) while simultaneously presented with photographs depicting a generic representation of that experience. Crucially, the photographs varied in terms of the affective valence depicted (e.g., a positive or negative flight) or the quantity of something depicted (e.g., a small or large crowd at a campus event). In line with past research (Nash, 2018; Sacchi et al., 2007), we predicted that the photographs presented to participants would bias judgments in the direction accentuated in the photographs, despite being generic and non-probative. For example, when the question asked of participants is “*How many books have you read in the past year?*”, we expected that a photograph depicting a

person surrounded by piles of book (“High Quantity” version) would bias responses towards a higher estimate of books read compared with a “Low Quantity” photo, in which a person shown reading a single book was presented.

Methods

Power analysis and design

Our primary experimental design, used in Experiments 1 through 3, consisted of one factor (either Affective or Quantitative photos) with two levels (Positive vs. Negative or High vs. Low). Based on past research (Nash, 2018) and judgments considering the particularities of our design, we estimated a small-to-medium effect size ($d=.4$) for the paired comparisons of responses between the photograph types (High vs. Low, Positive vs. Negative). G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) was used to estimate sample sizes sufficient to obtain a power level of .95 based on a two-tailed alpha level of .05. The analysis suggested that 84 participants would be needed per test. We acquired sample sizes that accorded closely with this recommendation.

Participants

Ninety-five Binghamton University undergraduate students participated for partial fulfillment of course credit. Participants were tested individually. Fifty-four were female. Eighty-seven stated that English was their first or native language.

Materials

A total of 40 questions were compiled (see Table 1), each of which probed different aspects of autobiographical memory for events or details about the past. Twenty questions involved a quantitative estimate (e.g., *How many books have you read in the past year?*, *Approximately how much money have you spent on groceries in the past month?*) and required that participants provide a quantity (e.g., amount of books, amount of money) to be given as a response. Such questions are hereby referred to as the *Quantitative* questions. The other 20 questions tapped the affective or emotional elements of an experience (e.g., *How pleasant was your last flight?*, *How painful do you remember your first shot being?*), and required participants to provide judgments of emotional intensity or degree of arousal (e.g., amount of joy/pain experienced, level of severity; see Table 1). These are referred to as the *Affective* questions throughout. The scales provided to participants for responding varied depending on the particular type of judgment (quantitative/affective) and the type of question. For the

Table 1 List of Quantitative questions used for Experiments 1 and 2

Quantitative questions

- Approximately, how many pounds of trash (food, paper, plastic, etc.) have you thrown away in the past month?
- Approximately, how much money have you spent on clothing in the past 3 months? (respond in US dollars)
- Approximately, how much money have you spent on groceries in the past month? (respond in US dollars)
- How many birds have you seen in the past month?
- How many books have you read in the past year?
- How many cups of coffee have you had in the past month?
- How many different fast-food chains have you been to?
- How many different television shows have you watched in the last year? (including unfinished seasons/series)
- How many emails have you received in the past week?
- How many friends do you remember having in high school?
- How many gallons of water do you think you consumed in the past month?
- How many movies have you seen in the past year?
- How many new songs have you heard in the past month?
- How many people were at the last concert you attended?
- How many people were at the last party you attended?
- How many people were at your high school prom?
- How many pounds of food have you eaten in the past month?
- How many text messages have you received in the past month?
- The last time you were at a theater, how many people were there?
- The last time you were at a university social gathering, how many people were there?

Affective questions

- How enjoyable was your last date?
- How enjoyable was your last snow day (i.e., classes cancelled)?
- How enjoyable was your last time at a restaurant?
- How painful do you remember your first shot being?
- How pleasant was the last dream you remember having?
- How pleasant was your first time on a rollercoaster?
- How pleasant was your freshman year of high school?
- How pleasant was your last family dinner?
- How pleasant was your last flight?
- How pleasant was your last holiday dinner?
- How pleasant was your last interaction with the police?
- How pleasant was your last time at a hotel?
- How pleasant was your last time at a movie theater?
- How pleasant was your last time at a supermarket?
- How pleasant was your last trip to the dentist?
- How pleasant was your last visit to the doctor?
- How serious was the last argument you've seen?
- How serious was the last motor vehicle accident you've seen?
- How severe was your last flu/cold?
- The last time you tried a new food, how enjoyable was it?

quantitative-oriented autobiographical questions, a 0–300 scale was used because we assumed most responses would

be adequately captured by that range. The scale always indicated that the value of 300 represented a response of 300 or greater. For the affective questions, all scales ranged from 1 to 6, 1 representing the most negative emotional reaction to the event; and 6 the most positive emotional evaluation. Selections between integers could also be selected on the affective rating scale.

A total of 80 photographs were acquired using Google image search (see Figs. 1 and 2). For each of the quantitative/numerical questions, two photos were found, one corresponding to a representation of a low quantity (e.g., a small number of people, one book, one cup of water) and the other to a high quantity (e.g., a large crowd of people, several stacks of books, several gallons of water). In a similar vein, two photographs were found for each of the affective/emotional autobiographical questions. One depicted a more affectively negative version of the event probed (e.g., a totaled car, an unpleasant economy class flight, an argument at a dinner table). The other depicted a more emotionally positive version of the event (a minor dent on a car, a first-class flight, a

Fig. 1 Example of Quantitative question presentation (a: High version, b: Low version). *Note:* Because of copyright, the photos shown in this paper were not the actual images used in the experiment, though they are similar. The images shown here are drawn from Pexels (<https://www.pexels.com>), a repository of public domain images. The photos actually used in the experiment were also displayed to the participants in color, not black and white. The images that were used can be found at <https://osf.io/znk7r/>

Fig. 2 Example of Affective question presentation (a: Positive version, b: Negative version). *Note:* Because of copyright, the photos shown in this paper were not the actual images used in the experiment, though they are similar. The images shown here are drawn from Pexels (<https://www.pexels.com>), a repository of public domain images. The photos actually used in the experiment were also displayed to the participants in color, not black and white. The images that were used can be found at <https://osf.io/znk7r/>

pleasant interaction among family at a dinner table). In Experiment 1, the judgments of the experimenters were used to assess the appropriateness of each of the photos picked for the purposes of depicting these qualities. See Experiment 2 for a more objective procedure.

Procedure

Participants were tested in individual rooms on Windows computers. They were told that they would be taking part in a general “Life Survey” regarding their personal pasts and that the answers they provided would be kept anonymous. At no point in the instructions were photographs mentioned and they were not instructed at all to use or look at the photographs to help make their judgments. All questions were displayed to the participants using PsychoPy (Peirce, 2007) software.

Participants were able to skip questions that they thought were not applicable to their lives by pressing the “N” key on the keyboard. After reading through the instructions on how to proceed, the 40 questions were provided to the participants and they selected their ratings on the scales using the mouse. Every question was presented with a content-related photograph, which appeared above the question. A rating scale appropriate to the question and a prompt reminding them how to make their response appeared below the question. (see Figs. 1 and 2 for schematic examples of the displays used). The photo, the question, and the scale appeared simultaneously, and the next question trial began after a selection was made on the scale. After completing the first set of 20 questions, the participants were informed that, “Again, you will be asked a few more questions about your life. Your responses will be kept anonymous,” and were subsequently provided with the next set. After completing the survey, participants were debriefed about the nature of the study.

Participants were randomly assigned to one of the two block orders, quantitative questions first or affective questions first. The order of the questions within each block was random. Question items were counterbalanced with regard to the type of photo they were paired with (“Negative” vs. “Positive”/“Low” vs. “High”) within each block. Half of the quantitative block items were paired with “High” photographs (10 items) and the other half paired with “Low” photographs (10 items). The same held for the affective block of questions, such that each participant only saw half of the total stimulus set of all photos.

Results

Two participants failed to complete the full block of quantitative questions due to technical errors, resulting in a total of 93 data points for the quantitative block and the full 95 data points for the affective block. The analyses in this experiment and all subsequent experiments were performed in R (R Core Team, 2019). Before the analyses were performed on the dependent variable of interest for each question type (mean values for quantitative estimates/affective ratings), each response for each of the 40 items was converted into a z-score with respect to the mean and standard deviation of each item. Overall means per block type (High vs. Low/Positive vs. Negative) for each subject were then calculated based on each item’s standardized value. Standardization was performed because of the variation in quantity types (from amount of money, to number of people, etc.) and experiences (pleasantness of police interactions, severity of vehicular accidents) asked about. Estimates of the effect of photographs across questions were then rendered more comparable. Because of indications of non-normality throughout, all analyses in Experiments 1–3 were

conducted using non-parametric methods.¹ Within the quantitative block, the non-parametric Wilcoxon signed-rank test was used. This test, which compared the two conditions (High vs. Low) on the z-scored quantity estimates, revealed a significant difference, such that participants provided higher quantity estimates regarding past events or details when high quantitative-value photographs ($M = 0.09$, $SD = 0.52$) were displayed compared to when low quantitative-value photographs ($M = -0.10$, $SD = 0.42$) were shown, $Z = -4.13$, $p < .001$, $r = 0.43$ (see Fig. 3).

A Wilcoxon signed-rank test was also performed on the differences between the positive versus negative conditions. For consistency of interpretation, the responses to four of the autobiographical questions were reverse-coded.² By reverse-coding, the direction of the effect is kept consistent with respect to the responses to the other questions, such that a higher value always represents a more “positive” interpretation of the event probed. The results of the analysis revealed a significant difference between conditions such that more positive photographs tended to elicit more positive values ($M = 0.06$, $SD = 0.35$) than did the negative photographs ($M = -0.06$, $SD = 0.41$), $Z = -2.29$, $p = .02$, $r = 0.24$ (see Fig. 4).

A final analysis was performed to examine the possible effect of order (whether the quantitative or affective questions were answered first) on the main effect of photo. First, we examined whether there was an effect of order in the quantitative block of questions. Because of the concerns about non-normally distributed data already noted, we used an analytical approach that relied on robust methods (Mair & Wilcox, 2019; Wilcox, 2012). For data within the quantitative block, a robust two-way ANOVA using 20% trimmed means (implemented through the WRS2 package; Mair & Wilcox, 2019) was performed that included block order (Affect block first vs. Quantitative block first) as a between-groups factor and photograph type (High vs. Low) as a within-subjects factor. This analysis found no significant interaction effect, $Q(1, 53.92) = 0.02$, $p = 0.90$. Order, whether the quantitative questions came before or after the affective block, did not appear to affect the manifestation of the photograph effect in this block. Regarding the affective block, a second robust two-way ANOVA was conducted on the affective questions with block order as a between-subjects factor. There was again no statistically significant effect of block order, $Q(1, 59.72) = 3.20$, $p = 0.08$, though the effect of photo appeared to be numerically greater following the quantitative questions (Positive: $M =$

¹ The data were also analyzed with parametric significance tests, the results of which were consistent with the nonparametric tests, unless noted otherwise.

² These were “How serious was the last argument you’ve seen?”, “How serious was the last motor vehicle accident you’ve seen?”, “How severe was your last flu/cold?”, “How painful do you remember your first shot being?” Higher ratings for these questions are more appropriately interpreted as more affectively negative.

Fig. 3 Plot representing Quantitative results for Experiment 1 (Exp 1), Experiment 2 (Exp 2), and Experiment (Exp 3). The stars represent statistical significance: * = $p < .05$. ** = $p < .01$. *** = $p < .001$. NS = not significant

0.09, $SD = 0.35$ vs. Negative: $M = -0.11$, $SD = 0.42$) compared to when the affective questions came first (Positive: $M = 0.03$, $SD = 0.36$ vs. Negative: $M = -0.004$, $SD = 0.40$).

Discussion

In this first experiment, we investigated which elements of autobiographical memories could be biased by photographs. Overall, the results show that the quantitative details of autobiographical memories (such as *How many people were at the last party you attended?*) or relatively more semantic content about the past (*How many books have you read in the past year?*) may be influenced by the simple presentation of generic photographs, and this influence appears to be biased in the direction depicted in the photo. Though we also found a significant effect of photograph type on affective evaluations/recollections of past autobiographical events, the effect was much less robust overall and was possibly more strongly manifested when the affective questions appeared later in the testing session, after responding to questions in the quantitative block. Given that this possible order effect was not statistically significant and was unanticipated, it should be interpreted with appropriate caution. In Experiment 2, we attempt to more cleanly test the effect of such photos without the possible

problems of cross-question-type contamination or carry-over-like effects.

Experiment 2

Experiment 1 showed that generic photographs can influence quantitative or numerical judgments/memories about past events. Consistent with past photographic manipulations regarding crowd size distortions (Nash, 2018; Sacchi et al., 2007), the presentations of large numbers of people/objects/items may also cause people to provide inflated estimates of quantitative elements of past autobiographical/personalized events. There was additionally some indication that generic photographs conveying different affective components could possibly influence affective autobiographical judgments. The results for the affective questions were more equivocal, first because the effect size was weaker overall and second because the effect of such positive/negative photographs seemed more likely to appear when autobiographical affective judgments were rendered *after* the quantitative questions were answered, though, again, the interaction effect with order was found to be nonsignificant. Nevertheless, the second set of experiments were conducted as a replication attempt, but in a between-subjects design, such that one group of participants only made

Fig. 4 Plot representing Affective results for Experiment 1 (Exp 1), Experiment 2 (Exp 2) and Experiment (Exp 3). The stars represent statistical significance: * = $p < .05$. ** = $p < .01$. *** = $p < .001$. NS = not significant

quantitative judgments, and another only made affective judgments. This design ensured that there was no spillover/contamination type effects from one set of judgments to another. We also conducted a manipulation check on a separate pool of participants to assess the degree to which the photos actually depicted the quantities or affective types we intended.

Methods

Participants

A total of 186 Binghamton University undergraduates participated in this study in return for partial fulfillment of course credit. Participants were tested individually. Responses to demographic questions indicated that 94 identified as female, 90 as male, and two as non-binary. Regarding language, 171 stated that English was their native or first language, 14 said that it was not, and one person chose not to answer.

Materials

The materials and stimuli in this experiment were identical to those in Experiment 1. Specifically, the autobiographical questionnaires and the photographs used in Experiment 1 were used again in Experiment 2 with no alterations. The only

change was that participants saw only one set of questions (either quantitative or affective) based on the condition to which they were randomly assigned. Furthermore, the scales, display format, and experimental software (PsychoPy) used in Experiment 1 were again used in Experiment 2.

Procedures

The procedures used in Experiment 2 were identical to those used in Experiment 1 except that participants saw only 20 questions and only questions of a specific type (affective vs. quantitative) based on their assigned condition. Therefore, the overall session was approximately half the duration as in Experiment 1. The same counterbalancing measures were taken in Experiment 2 as in Experiment 1.

Results

At the end of data collection, 93 participants had been randomly assigned to the quantitative condition and 93 participants had been randomly assigned to the affective condition. The same standardization procedure used in Experiment 1 was again used before the analyses were conducted. In the quantitative condition, the Wilcoxon signed-rank test was used to determine whether there was a difference in numerical

estimates based on the type of photograph participants were presented. The results showed that when participants received the “high” photographs they responded with higher quantitative estimates ($M = 0.03$, $SD = 0.39$) compared to when they received the “low” photographs ($M = -0.04$, $SD = 0.49$), $Z = -2.76$, $p = 0.006$, $r = 0.29$ (see Fig. 3).³ For the affective condition, a Wilcoxon signed-rank test was again conducted to assess whether photograph type influenced affective evaluation of past events. Results indicated that there was no significant difference in ratings between when participants were shown the “positive” photos ($M = 0.02$, $SD = 0.39$) compared with when they were shown the “negative” ones ($M = -0.02$, $SD = 0.45$), $Z = -0.95$, $p = 0.34$, $r = 0.10$ (see Fig. 4).

Discussion

This second experiment was essentially an effort to replicate the results of the first, with the only change being that the survey questions were presented such that each participant only received affective questions or quantitative questions. For the quantitative condition of Experiment 2, the results were largely consistent with the results of the first experiment. Again, it appears that the quantities depicted, or the numerical elements emphasized in these generic photographs biased the estimates made by the participants. On the other hand, the results of the analysis within the affective condition suggest that the effect of photographs may be appreciably more fragile on emotional/affective evaluations of past events. In a way, this is consistent with the results of Experiment 1, where the overall effect size of the affective photos was smaller than that of the quantitative photographs. Furthermore, the results seem to suggest that without the preceding quantitative block of questions, the effect of affective photographs was essentially non-existent. Alternatively, the affective results of Experiment 1 could be a false positive.

Manipulation check

We also considered the possibility that our photographic stimuli may have been more effective at depicting quantity than emotion. If it turns out that the quantitative photographs more clearly conveyed the quantity than the affective photographs conveyed the emotion, this may account for the discrepancy between our effects and would necessitate a reassessment of the stimuli used. Using a separate pool of 40 Binghamton University undergraduate students (30 female, 36 with English as their native or first language), we performed what was essentially a manipulation check. The photographic

stimuli used were identical to those in Experiments 1 and 2. The key change was in the questions they were asked. The questions posed were directly regarding the content of the images displayed, and, unlike the autobiographical questionnaire, drew participants’ attention to the photo in question. For the quantitative photographs, the questions concerned how many objects or persons were depicted. For example, for a photograph of a well-attended concert, participants were asked, “*How many people would you estimate are in this photo?*” For affective photographs, questions regarding the affect/emotionality/intensity of the photograph were posed. For example, when presented with a photo of people arguing at a dinner table, participants would be asked, “*How pleasant is this experience for the person(s) depicted?*” Twenty participants were randomized to receive the quantitative questions, and the other 20 were assigned to the affective questions.

A Wilcoxon signed-rank test was conducted on the z-scored responses to the quantitative questions. As predicted, those photographs depicting a higher quantity were given higher estimates ($M = 0.83$, $SD = 0.29$) and those depicting a lower quantity were given lower estimates ($M = -0.83$, $SD = 0.07$), $Z = -4.76$, $p < 0.001$, $r = 1.07$. Similarly, participants rated the positive photographs as significantly more positive ($M = 0.82$, $SD = 0.36$) and negative photos as more negative ($M = -0.82$, $SD = 0.21$), $Z = -4.76$, $p < 0.001$, $r = 1.07$. In order to test whether the difference between high versus low photographs was larger than the difference between positive versus negative photos on their respective judgments, a robust two-way ANOVA using 20% trimmed means (Photo Type $\times$ Question Type) was performed due to the deviations from normality noted earlier. This test indicated that there was no interaction, $Q(1, 14.92) = 0.23$, $p = 0.64$, with the effect of photo not being different depending on the type of question (quantitative vs. affective). It appears that the manipulation check supports our initial judgments regarding what meaning the photographs convey and that the differences between the higher and lower depiction were comparable for the quantitative and affective questions.

Experiment 3

Given the results of the manipulation check, why is the effect of photograph on autobiographical memory seemingly stronger and more consistent in the quantitative condition than in the affective condition? Could it be that questions probing autobiographical events of an emotional nature would be *less* susceptible to influence of the photographs than autobiographical judgments regarding quantities? There is reason to think that this is true. One consideration is that it may not be common, even in a survey-saturated world, for people to be asked several of the questions posed in the quantitative portion of the experiment. Although we have no formal data collected on

³ A paired t-test, the parametric alternative, revealed a non-significant finding, $t(92) = 1.85$, $p = .07$. It should be noted here that a Shapiro-Wilk normality test for this block revealed strong deviations from normality, $W = .903$, $p < .001$. Therefore, we think it is justified to put greater weight on the non-parametric test results.

this specific point, it seems likely that this may very well be the first time many in our sample were asked about the number of birds they have seen in the past month or the amount of trash, in pounds, they have thrown away recently. Those are simply not questions asked of people with any regularity. This being the case, one might surmise that our participants probably did not have any firmly entrenched memories regarding some of those matters, and thus their judgments may be relatively malleable.

On the other hand, with the affective items, it seems that a greater number of those questions are of the sort more likely to be discussed in everyday conversation (e.g., recounting an unpleasant airline flights), and are therefore more likely to have a memory or belief of some type associated with them. Additionally, some of the affective questions might be tapping into more salient (in terms of arousal) features of events in general. For example, a university student likely has a more confident opinion (and remembrance) of their most recent date than of the number of people in the audience of their last theater outing. In other words, the emotional valence in the dating example is likely to be central to the memory itself, while the number of people in the theater is a peripheral detail, perhaps less likely to be rehearsed and less easily remembered. It has been shown that memory for focal details of emotional events can be particularly robust (e.g., Kensinger, 2009). All of this is to say that there could be a greater degree of haziness about the numerical specifics of the past than the emotional qualities of rather notable events in a person's life (e.g., last police interaction). These conditions of relative uncertainty or lack of precise knowledge about the quantitative aspects of these memories may lead to greater reliance on more heuristic reasoning (Tversky & Kahneman, 1974), which may also include the use of irrelevant cues/stimuli, such as the available photographs. An example from the recent literature on a related phenomenon illustrates this point. The finding that non-probative images tend to increase the degree of belief in the statements they are paired with, termed the “truthiness effect,” is more likely to manifest when there is some ambiguity or lack of knowledge regarding the actual truth or falsity of the statements evaluated (Newman et al., 2012). To the extent that our participants have relatively less knowledge/certainty about the subject matter of the quantitative-oriented questions vis-à-vis the affective questions, we should expect a greater influence of photographs when answering them, also explaining the disparity in effect sizes/observance of the effect across conditions.

In Experiment 3, we attempted to assess this possibility. In Experiments 1 and 2, participants were asked autobiographical questions regarding their *pasts*. In Experiment 3, participants were instead asked questions about their *futures*. This was in part an attempt to increase the likelihood that participants would approach their judgments in these future-oriented

scenarios with less certainty or have less firmly held beliefs regarding them, given that the events and actions in question have not happened yet. In line with past research, it was thought that the inherent ambiguity of the future would lead to a greater reliance on heuristics, such as the paired photographs. We also sought to extend prior research showing that memory-biasing manipulations can also be used to shape perceptions of the future (Gregg et al., 2019; Newman et al., 2018; Westerman et al., 2017). However, although it was not expected that an effect-size disparity between the quantitative and affective conditions would necessarily be eliminated in Experiment 3, it was expected that the effect size in the affective condition would at least be stronger than in Experiment 2.

Methods

Participants

A total of 204 Binghamton University undergraduates participated in this study in return for partial fulfillment of course credit. Participants were tested individually. Our demographic questions revealed that 145 identified as female and 59 as male, while 184 stated that English was their native or first language.

Materials

An altered version of the autobiographical question set used in prior experiments was used in Experiment 3. With a few exceptions, the majority of the questions featured in this experiment were simply future-oriented versions of the same questions already used. For example, instead of asking how many people were at the *last* concert they attended, participants were asked instead to estimate how many people they thought would be at the *next* concert they attend. In those instances where a future version of the question could not be created (i.e., those related to high school), new questions were used instead. Three such questions (two in the Quantitative condition and one in the Affective condition) were created as replacements for this experiment.⁴ The display in the manner of the scales and software used were identical to those used in the previous experiments.

⁴ The questions removed for Experiment 3 were “How many friends do you remember having in high school?”, “How many people were at your high school prom?”, and “How pleasant was your freshman year of high school?” They were replaced with “How many different sports cars do you think you will see on the road or in parking lots in the next month?”, “By the end of the next month, how many pages of paper do you think you will print?”, “How pleasant do you think this school year will be?”

Procedure

As in Experiments 1 and 2, participants were told that they would be participating in a survey about their lives. However, instead of being told that the questions posed would be about their past, they were informed that the questions would be related to their futures. Like Experiment 2, participants were randomized into either a Quantitative or an Affective condition, wherein they received only the quantitative or the affective portions of the question set, respectively. Therefore, all participants received only 20 questions. Again, photographs (half “high,” half “low” in the Quantitative condition; half “positive,” half “negative” in the Affective conditions) were paired and counterbalanced with each question and were displayed in the same manner as in Experiments 1 and 2. There were no instructional differences dependent on the condition they were assigned. As in the previous experiments, the participants were not told to use or even look at the photographs paired with questions. After completing the “survey,” participants were debriefed.

Results

Upon completion of data collection, 97 participants had been randomly assigned to the Quantitative condition and 107 had been randomly assigned to the Affective condition. The slight imbalance between conditions was a result of a clerical/experimenter error. A standardization of the data, identical to the procedure used in Experiments 1 and 2, was performed before tests were conducted. Wilcoxon signed-rank tests were used for the following analyses for both conditions. For the quantitative condition, the comparison of interest again was between trials within which “high” photos were presented versus when “low” photos were presented. Results showed that participants rendered higher quantitative-related autobiographical future estimates when presented with “high” photos ($M = 0.08$, $SD = 0.45$) compared to when they were presented with “low” photos ($M = -0.09$, $SD = 0.44$), $Z = -3.64$, $p < 0.001$, $r = 0.37$ (see Fig. 3). For responses to the affective autobiographical questions, results revealed that the “positive” photos tended to elicit more positive ratings ($M = 0.08$, $SD = 0.46$) regarding future events, while “negative” photos tended to elicit more negative ratings ($M = -0.08$, $SD = 0.51$), $Z = -2.84$, $p = 0.005$, $r = 0.27$ (see Fig. 4).

Discussion

In this final experiment, we aimed to extend the paradigm established in the prior two experiments into a future-oriented domain. By way of heightening the level of uncertainty experienced when answering the questions, we thought it possible that a greater biasing effect of photographs would be observed. Overall, these results were consistent with our

hypotheses. While the quantitative results for this last experiment, showing that the “high” photographs tended to yield higher estimates than “low” photos, are consistent to a large extent with the prior results, the affective results of Experiment 3 diverge from those found in Experiment 2. In line with our thinking that casting the autobiographical questions into the future would enhance the use of the photographs, we found a biasing influence of the photo’s depicted valence on responses to the affective questions such that those photographs displaying more “positive” content tended to lead to higher (more positive) affective ratings about future events.

Summary of experiments

Experiments 1, 2, and 3 showed consistently that autobiographical judgments regarding quantity can be influenced based on which photographs are presented (photographs depicting a high quantity vs. low quantity of people or movies). Regarding affect-related autobiographical judgments, what emerges is suggestive evidence of the influence of photographs, particularly when thinking about the future. The results of Experiment 1 provided some support for the notion that generic photographs can color thinking about past autobiographical events, with more positive images tending to elicit more positive autobiographical judgments relative to the negative images. In contrast, Experiment 2, in which participants only received one version (affective or quantitative) of the autobiographical questionnaire, found no evidence for this effect of photo. Finally, Experiment 3, which replicated the design of Experiment 2, but focused on the personal future instead of the past, again found some evidence for an effect of photo on affective autobiographical judgments.

General discussion

That photographs and images can be effective in creating false memories is well known (Wade et al., 2017). What is less firmly established are what other elements of memory can be influenced by photographs and in what ways. The findings presented here demonstrate subtler influences of memory manipulation through photos. Extending previous work, we found that content-related, but generic, ordinary photographs (such as the images available at standard stock photograph repositories on the web), can influence memory beliefs and judgments about one’s personal past in broadly similar ways that doctored photographs can (e.g., Sacchi et al., 2007). We also extend prior findings by demonstrating such effects in the domain of future autobiographical judgments.

There were unanticipated results that require an attempt at explication. For example, why did the effect seem to manifest

more strongly and consistently on the quantitative questions vis-à-vis affective ones? One possibility was that the photographs chosen for the quantitative judgments were more capable of bringing to mind the concepts of “highness” or “lowness” than the affective photos were in evoking “positivity” or “negativity.” However, as indicated in Experiment 2, it is hard to square this explanation with our norming data showing that the difference between ratings of high versus low photos was not greater than the difference between positive versus negative photos. Nonetheless, there are other characteristics of the photographs that may have varied between the judgment types that were not accounted for. For example, it is well established that emotional stimuli tend to be more attention grabbing than neutral/non-emotional stimuli (Carretié, Hinojosa, Martín-Loeches, Mercado, & Tapia, 2004; Öhman, Flykt, & Esteves, 2001; Vuilleumier & Schwartz, 2001). This being the case, it is plausible that the affective stimuli used might attract participants’ attention more easily or to a greater extent than those used on the quantitative trials. There is indication in the literature on “subconscious processing” or priming, more generally, that an awareness of the manipulation tends to deprive it of its effective potency on judgments, particularly if one can guess *how* the manipulation exerts its effects (Bargh, 2016). To the extent that a nontrivial number of the affective photographs were especially salient to the participants and therefore likely to garner attentional focus, they could recognize that the photograph may influence their judgments on the relevant trials, resulting in a compensatory effort on their part to counter this influence. If these assumptions hold, it could explain partially why the effect of photo is diminished within the domain of affective judgments. Further research would be needed to determine what role awareness might play in this divergence. Collecting awareness data after the experiment would be one way to address this issue.

The nature of the judgments themselves may also be a possible factor explaining the more powerful effects of photos in the quantitative condition. Many of the past events referenced in the quantitative questionnaire for Experiments 1 and 2 may have been less salient and thus less memorable than those in the affective questionnaire. It was therefore a possibility that generic photos would be less likely to figure into the affective past judgments since they likely referred to more striking memories (e.g., encounters with the police, dates, motor vehicle accidents, etc.) Additionally, there is prior literature suggesting that emotion and arousal can confer mnemonic benefits upon the focal elements of emotional events (Kensinger, 2009; Kensinger & Schacter, 2016). On this basis, it might be conjectured that memories for those emotional events would be less prone to being distorted. It is also broadly accepted that some categories of emotional memories (vis-à-vis non-arousing/emotional ones) can be held and recalled with a greater degree of confidence, irrespective of their fidelity to actual occurrences (Talarico &

Rubin, 2003). This higher confidence with which such emotional memories are held could also make biasing and manipulation of them less effective compared to non-emotional memories that might be much less confidently remembered. Experiment 3 attempted to partially address this issue by moving the judgments into the (less certain) future. The results indeed suggest that increasing the degree of ambiguity by making the questions about future events instead of past ones increased the likelihood of the photographs coloring participants’ judgments, as might be expected from the heuristics literature (e.g., Tversky & Kahneman, 1974). It should be noted, however, that the effect of photographs was still somewhat stronger in the quantitative condition. This could simply reflect the fact that such future judgments were likely still informed by past events, particularly if those events were salient.

What theoretical mechanism or mechanisms could be driving the observed effect that photos have on these autobiographical judgments? One possibility, as discussed previously, is that viewing the photographs may increase the accessibility of certain related concepts (e.g., a photograph of a flock of birds brings to mind related mental images), and this experienced fluency is then misattributed to pastness given how easily such concepts came to mind (e.g., leading one to think that they have seen many birds recently). Indeed, enhanced processing fluency has often been considered a plausible mechanism of false memory production through related photographs in other settings and experimental contexts (Cardwell et al., 2016; Nash, 2018; Wilson & Westerman, 2018). Another possibility is that the photographs could be acting as retrieval cues, calling forth memories of events or details about their pasts that are related to the content of the photo in some way. These recollections may subsequently affect their responding to the questions. For example, on one question in the quantitative block, participants were asked about the number of television series they have seen in the past year. In the low photograph condition, participants are shown a picture of a DVD case for one television show. For the high photograph trial, they are shown an array of promotional images for a variety of television shows. For those shown this high version, the photograph may remind them of certain shows that they had watched in the past year and would otherwise not have retrieved had they been shown the low version of the photo. That the photos might be aiding retrieval would be consistent with findings that photographs can increase recall of details for past events (Koutstaal et al., 1998). The results of Experiment 3, however, do leave open the possibility that retrieval may not be the whole story since the judgments made were not about past events, but future ones.

A limitation of our study is that we lack the data to sufficiently discriminate between these mechanisms. The results regarding the affective judgments are also limited, especially

given the inconsistent patterns and sizes of the effects observed. It is plausible that interventions aimed at modifying current mood/affect can shape the way we think about the past (e.g., Patihis, Cruz, & Herrera, 2019), though given the replicability problems that have plagued the notion that modest manipulations can have substantial effects, it is appropriate to be cautious when interpreting our results. Another limitation pertains to the specific stimuli used. The importance of the particularity of the stimuli is often underestimated by researchers. That our materials (both photographs and questions) could be adequately representative of the types of images or questions used in the real world was based more on impressionistic judgments than comprehensive investigation. The generalizability of our findings would be further strengthened if a wider variety of stimuli was tested. It is not known to what extent the findings are specific to the photographs or question items we used here (for item-level variance, see Appendix 1).

Possible implications and applications

Our findings may have implications for research into the influence of social media on memory. For one, it is possible that even the most innocuous of images can have effects on memory or our thoughts about the future, as the photographs used here are akin to stock photographs of the kind in casual use all over the internet, either paired with online news stories or for the enhancement of user experience. Secondly, researchers should be mindful of the subtler effects that photographs might have. In our experiments, photographs were not used with the intention of manufacturing memories completely, but to examine to what extent certain elements of these memories might be differentially appraised based on the images that are seen. That we do find such effects indicates that ordinary photographs that are not purposefully misleading might still have memorial consequences that could be missed if we concern ourselves strictly with false memory creation of entire events. On a practical level, those engaged in survey research would be careful to ensure that possibly suggestive photographs are entirely avoided when possible, particularly if such research is carried out online where images of all sorts abound. Those pop-ups and advertisements might be more cognitively consequential than we typically appreciate.

Appendix 1

Could it be that a limited subset of the stimuli or questions are the primary drivers of the observed overall effect? In an attempt to address this concern, we first calculated effects sizes (Cohen's d) for the comparison of means between the two photo types (i.e., High vs. Low; Positive vs. Negative) for

each survey question⁵ (see Tables 2 and 3). We then examined the correlation between the rankings of these effect size measurements for each of the questions across Experiments 1 and 2.⁶ If the effect is being driven primarily by one or a few questions or image pairs, we would expect these to occupy the ranks of the strongest effects across the two experiments. However, there was not a significant correlation among rankings for the Quantitative questions $r_s(18) = 0.41$, $p = 0.08$, nor the Affective questions, $r_s(18) = 0.12$, $p = 0.62$. As can be judged from the table, there were clearly substantial differences in effect sizes between questions and the contribution of a few specific questions could be considered inordinate. However, these correlational analyses indicate that the specific items contributing to the overall effect varied enough across experiments to cast doubt on item effects being a key factor accounting for the main findings. All this said, we do not have sufficient data to judge why we see this variation among the stimuli we used. Are some types of questions just less amenable to such photographic manipulation or would the use of a different set of photograph pairs have made more of a difference in at least some instances? Further investigatory work to uncover the reasons for these item-specific differences might be warranted.

Appendix 2

Could it be that participants possess a greater motivation to more accurately recall information related to affectively charged events?⁷ They might do so precisely because of their salience, as discussed in the *General discussion*. If so, it might be expected that participants would spend more time thinking about the affective judgements before they made their responses compared to when they were faced with the quantitative ones. Contrary to this supposition, decision time data suggests that, in Experiment 1, participants spent more time on the Quantitative questions ($Mdn = 9.38$ s, $SD = 3.82$) than on the Affective questions ($Mdn = 5.5$ s, $SD = 2.01$), $Z = -8.13$, $p < 0.001$, $r = 0.84$. For Experiment 2, participants also showed longer reaction times (RTs) in the Quantitative condition ($Mdn = 9.59$, $SD = 4.89$) than in the Affective condition ($Mdn = 5.19$, $SD = 3.16$), $U = 6964$, $p < 0.001$, $r = 0.61$ (Mann-Whitney U test). The same pattern held for Experiment 3 as well (Quant condition: $Mdn = 10.87$ s, $SD = 4.05$, Affective condition: $Mdn = 5.43$, $SD = 2.24$; $U = 9250$, $p < 0.001$, $r = 0.78$). Do these results suggest that people were actually more motivated to accurately provide quantitative estimates? We do not necessarily think so. It could be the case that, in attempting to provide a remotely precise answer to the

⁵ This analysis is not dissimilar to that of Sacchi et al. (2007) and Nash (2018), who analyzed the influence of manipulated photographs on a per-question basis.

⁶ Recall that the third experiment uses different stimuli because of its shift in temporal perspective and therefore excluded from consideration.

⁷ We thank a reviewer for suggesting this possibility.

Table 2 Effect size by question type for Experiments 1 and 2, Quantitative questions (High vs. Low)

Question's type	E1: Cohen's <i>d</i>	E2: Cohen's <i>d</i>
How many birds have you seen in the past month?	0.744	0.325
How many new songs have you heard in the past month?	0.672	0.198
How many movies have you seen in the past year?	0.639	0.395
How many different fast-food chains have you been to?	0.570	-0.130
How many people were at the last concert you attended?	0.544	0.621
How many books have you read in the past year?	0.412	-0.346
The last time you were at a theater, how many people were there?	0.393	0.269
The last time you were at a university social gathering, how many people were there?	0.328	0.668
How many cups of coffee have you had in the past month?	0.263	-0.160
Approximately, how much money have you spent on groceries in the past month? (respond in US dollars)	0.233	0.012
How many people were at the last party you attended?	0.218	0.271
Approximately, how much money have you spent on clothing in the past 3 months? (respond in US dollars)	0.154	-0.140
Approximately, how many pounds of trash (food, paper, plastic, etc.) have you thrown away in the past month?	0.011	-0.094
How many pounds of food have you eaten in the past month?	0.010	-0.277
How many gallons of water do you think you consumed in the past month?	0.005	-0.247
How many text messages have you received in the past month?	-0.065	0.241
How many different television shows have you watched in the last year? (including unfinished seasons/series)	-0.180	-0.010
How many friends do you remember having in high school?	-0.226	-0.133
How many emails have you received in the past week?	-0.273	0.261
How many people were at your high school prom?	-0.279	-0.161

quantitative questions, moving the slider to select a choice on a wider-ranging scale turned out to be a more involved task

compared to selecting a choice on a 1–6 scale. Alternatively, these results may suggest that people are ignoring the

Table 3 Effect size by question type for Experiments 1 and 2, Affective questions (Positive vs. Negative)

Question's Type	E1: Cohen's <i>d</i>	E2: Cohen's <i>d</i>
How pleasant was your last holiday dinner?	0.517	0.129
How pleasant was your last flight?	0.446	0.298
How pleasant was the last dream you remember having?	0.356	-0.244
How enjoyable was your last time at a restaurant?	0.351	0.304
How pleasant was your last family dinner?	0.288	0.182
How pleasant was your last time at a supermarket?	0.244	0.395
How pleasant was your last interaction with the police?	0.241	0.116
How severe was your last flu/cold?	0.234	-0.279
How enjoyable was your last snow day (i.e., classes cancelled)?	0.203	-0.119
The last time you tried a new food, how enjoyable was it?	0.181	-0.308
How serious was the last argument you've seen?	0.024	0.163
How pleasant was your last time at a movie theater?	0.002	-0.014
How pleasant was your last time at a hotel?	-0.001	0.015
How pleasant was your last visit to the doctor?	-0.030	-0.100
How painful do you remember your first shot being?	-0.038	-0.049
How pleasant was your freshman year of high school?	-0.041	-0.199
How serious was the last motor vehicle accident you've seen?	-0.106	-0.220
How pleasant was your first time on a rollercoaster?	-0.123	-0.099
How pleasant was your last trip to the dentist?	-0.234	0.203
How enjoyable was your last date?	-0.293	0.640

photographs in the Affective condition (for an interpretation of RTs along these lines in the context of Truthiness, see Newman et al., 2015). This might be because participants were more confident about their emotional reactions to salient events than they were about more mundane numerical judgements, lending some support to the notion that confidence in emotional judgements might be acting to attenuate the influence of photos.

References

- Addis, D. R., Sacchetti, D. C., Ally, B. A., Budson, A. E., & Schacter, D. L. (2009). Episodic simulation of future events is impaired in mild Alzheimer's disease. *Neuropsychologia*, 47(12), 2660–2671.
- Bargh, J. A. (2016). Awareness of the prime versus awareness of its influence: implications for the real-world scope of unconscious higher mental processes. *Current Opinion in Psychology*, 12, 49–52.
- Berntsen, D., & Bohn, A. (2010). Remembering and forecasting: The relation. *Memory & Cognition*, 38(3), 265–278.
- Blandón-Gitlin, I., & Gerkens, D. (2010). The effects of photographs and event plausibility in creating false beliefs. *Acta psychologica*, 135(3), 330–334.
- Cardwell, B. A., Henkel, L. A., Garry, M., Newman, E. J., & Foster, J. L. (2016). Nonprobative photos rapidly lead people to believe claims about their own (and other people's) pasts. *Memory & cognition*, 44(6), 883–896.
- Carretié, L., Hinojosa, J. A., Martín-Loeches, M., Mercado, F., & Tapia, M. (2004). Automatic attention to emotional stimuli: neural correlates. *Human brain mapping*, 22(4), 290–299.
- D'Argembeau, A., & Van der Linden, M. (2004). Phenomenal characteristics associated with projecting oneself back into the past and forward into the future: Influence of valence and temporal distance. *Consciousness and cognition*, 13(4), 844–858.
- 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.
- Frenda, S. J., Knowles, E. D., Saletan, W., & Loftus, E. F. (2013). False memories of fabricated political events. *Journal of Experimental Social Psychology*, 49(2), 280–286.
- Gregg, J., Upadhyay, S. S. N., Kuntzelman, K., Sacchi, E., & Westerman, D. L. (2019). Parallel effects of retrieval ease on attributions about the past and the future. *Acta psychologica*, 193, 96–104.
- Henkel, L. A. (2011). Photograph-induced memory errors: When photographs make people claim they have done things they have not. *Applied Cognitive Psychology*, 25(1), 78–86.
- Henkel, L. A., & Carbuto, M. (2008). Remembering what we did: How source misattributions arise from verbalization, mental imagery, and pictures. In M. R. Kelley (Ed.), *Applied memory* (pp. 213–234). Hauppauge, NY: Nova Science Publishers Inc.
- Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review*, 1(2), 99–113.
- Kensinger E. A., & Schacter D. L. (2016). Memory and emotion. In L. F. Barrett, M. Lewis, J. M. Haviland-Jones (Eds.), *Handbook of Emotions* (pp. 564–578). (4th ed.) New York: Guilford Press.
- Koutstaal, W., Schacter, D. L., Johnson, M. K., Angell, K. E., & Gross, M. S. (1998). Post-event review in older and younger adults: Improving memory accessibility of complex everyday events. *Psychology and Aging*, 13(2), 277–296.
- Lindsay, D. S., Hagen, L., Read, J. D., Wade, K. A., & Garry, M. (2004). True photographs and false memories. *Psychological Science*, 15(3), 149–154.
- Mair, P., & Wilcox, R. (2019). Robust statistical methods in R using the WRS2 package. *Behavior research methods* <https://doi.org/10.3758/s13428-019-01246-w>
- Marsh, E. J., & Rajaram, S. (2019). The digital expansion of the mind: Implications of internet usage for memory and cognition. *Journal of Applied Research in Memory and Cognition*, 8(1), 1–14.
- Murphy, G., Loftus, E. F., Grady, R. H., Levine, L. J., & Greene, C. M. (2019). False Memories for Fake News During Ireland's Abortion Referendum. *Psychological Science*. Advance online publication. <https://doi.org/10.1177/0956797619864887>
- Nash, R. A. (2018). Changing beliefs about past public events with believable and unbelievable doctored photographs. *Memory*, 26(4), 439–450.
- Nash, R. A., Wade, K. A., & Brewer, R. J. (2009). Why do doctored images distort memory?. *Consciousness and Cognition*, 18(3), 773–780.
- Newman, E. J., Garry, M., Bernstein, D. M., Kantner, J., & Lindsay, D. S. (2012). Nonprobative photographs (or words) inflate truthiness. *Psychonomic Bulletin & Review*, 19(5), 969–974.
- Newman, E. J., Garry, M., Unkelbach, C., Bernstein, D. M., Lindsay, D. S., & Nash, R. A. (2015). Truthiness and falsiness of trivia claims depend on judgmental contexts. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 41(5), 1337–1348.
- Newman, E. J., Azad, T., Lindsay, D. S., & Garry, M. (2018). Evidence that photos promote rosiness for claims about the future. *Memory & cognition*, 46(8), 1223–1233.
- Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: detecting the snake in the grass. *Journal of experimental psychology: general*, 130(3), 466–478.
- Patihis, L., Cruz, C. S., & Herrera, M. E. (2019). Changing Current Appraisals of Mothers Leads to Changes in Childhood Memories of Love Toward Mothers. *Clinical Psychological Science*, 7(5), 1125–1143.
- Peirce, J. (2007). PsychoPy—psychophysics software in Python. *Journal of Neuroscience Methods*, 162, 8–13.
- R Core Team (2019). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from <http://www.R-project.org/>
- Sacchi, D. L., Agnoli, F., & Loftus, E. F. (2007). Changing history: Doctored photographs affect memory for past public events. *Applied Cognitive Psychology*, 21(8), 1005–1022.
- Schacter, D. L. (2012). Adaptive constructive processes and the future of memory. *American Psychologist*, 67(8), 603–613.
- Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K. (2012). The future of memory: remembering, imagining, and the brain. *Neuron*, 76(4), 677–694.
- Strange, D., Garry, M., Bernstein, D. M., & Lindsay, D. S. (2011). Photographs cause false memories for the news. *Acta Psychologica*, 136(1), 90–94.
- Szpunar, K. K., Watson, J. M., & McDermott, K. B. (2007). Neural substrates of envisioning the future. *Proceedings of the National Academy of Sciences*, 104(2), 642–647.
- Talarico, J. M., & Rubin, D. C. (2003). Confidence, not consistency, characterizes flashbulb memories. *Psychological Science*, 14(5), 455–461.
- Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 185(4157), 1124–1131.
- Vuilleumier, P., & Schwartz, S. (2001). Emotional facial expressions capture attention. *Neurology*, 56(2), 153–158.
- Wade, K. A., Garry, M., Read, J. D., & Lindsay, D. S. (2002). A picture is worth a thousand lies: Using false photographs to create false childhood memories. *Psychonomic bulletin & review*, 9(3), 597–603.

- Wade, K. A., Nightingale, S. J., & Colloff, M. F. (2017). Photos and memory. In R. A. Nash & J. Ost (Eds.), *False and Distorted Memories*, (pp. 39-54). Hove, UK: Psychology Press.
- Westerman, D. L., Miller, J. K., & Lloyd, M. E. (2017). Revelation effects in remembering, forecasting, and perspective taking. *Memory & cognition*, 45(6), 1002-1013.
- Wilcock, R. A., Bull, R., & Vrij, A. (2007). Are old witnesses always poorer witnesses? Identification accuracy, context reinstatement, own-age bias. *Psychology, Crime & Law*, 13(3), 305-316.
- Wilcox, R. (2012). *Introduction to Robust Estimation and Hypothesis Testing*, 3rd Edn. Waltham, MA: Academic Press.
- Wilson, J. C., & Westerman, D. L. (2018). Picture (im) perfect: Illusions of recognition memory produced by photographs at test. *Memory & cognition*, 46(7), 1210-1221.
- Zhang, L., Newman, E. J., & Schwarz, N. (2021). When photos backfire: Truthiness and falsiness effects in comparative judgments. *Journal of Experimental Social Psychology*, Advance online publication. <https://doi.org/10.1016/j.jesp.2020.104054>
- Open Practices Statement**
- Data files, stimuli used, and analysis code are available at <https://osf.io/znk7r/>. None of the experiments reported were preregistered.
- Publisher's note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.