RUNNING HEAD: Perspectives in Photographs

Third-Person Perspectives in Photographs Influence Visual and Spatial Perspectives during
Subsequent Memory Retrieval

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Abstract

We frequently review photographs of the past, which can influence our subsequent memories for these events. Although photographs always portray events from a particular viewpoint, there is minimal research examining the influence of viewpoint during photographic review of memories. In the current study, we examined how reviewing photographs from first-person versus third-person perspectives influenced the visual perspective (i.e., line of sight) and spatial perspective (i.e., spatial relationship of objects) in subsequent memories. Participants formed memories for mini-events performed in the lab, reviewed photographs of these events one week later from first-person and third-person perspectives, and then two days later memories for these events were tested against no photographic review. We found that third-person photographs increased the tendency to adopt an observer-like perspective during subsequent remembering, suggesting that photographic review of novel viewpoints changes the location from which the rememberer views the past event. Reviewing third-person photographs also reduced the accuracy of the spatial location of objects with respect to the original viewpoint during memory formation, indicating that photographic review can also update the spatial perspective of objects in the retrieved event. In sum, these findings show that the viewpoint of photographs can powerfully influence memories.

KEYWORDS: Visual Perspective, Episodic Memory, Mental Imagery, Photographs, Subsequent Memory

Photographs of past events can depict a first-person viewpoint, capturing the moment from the same own eyes perspective as we originally experienced the event, as well as multiple third-person viewpoints taken by someone else at the time of the event or by ourselves in the case of selfies, where we see ourselves from an observer-like perspective. Although a number of studies have examined the influence of photographs on memory, few have directly investigated how reviewing first-person and third-person photographs might differentially affect memories for events. During remembering, it is well known that we can form mental images of events in which we see ourselves in the memory from an external vantage point (observer-like perspective), or where we view the past from an own eyes perspective, re-experiencing the event from the same viewpoint from which the event was initially encoded (Nigro & Neisser, 1983). Visual perspective influences how memories are remembered (Rice, 2010) and the underlying neural mechanisms supporting memory retrieval (Iriye & St Jacques, 2020b), and these changes in the characteristics of memories can persist overtime (St. Jacques, 2019). In everyday life, shifts in visual perspective in memory may occur deliberately (e.g., actively imagining an alternative viewpoint in the retrieved event), or more automatically (e.g., remembering from the viewpoint shown in a photograph). Recently, we demonstrated that actively shifting visual perspective during memory retrieval cued by a third-person photograph reduced the accuracy of memory on a subsequent cued-recall test and also decreased own eyes perspective ratings during later remembering (Marcotti & St Jacques, 2018). Other research, however, has shown that passive review of photographs taken from alternative points of view can also reduce subsequent memory accuracy (St Jacques & Schacter, 2013). In the current study we examined the influence of passive versus active instructions to shift visual perspective during retrieval of memories for events cued by photographs taken from first-person and third-person perspectives.

Photographs can be effective retrieval cues to elicit the personal past (for reviews see Chow & Rissman, 2017; Silva, Pinho, Macedo, & Moulin, 2013) but can also influence how these events are later remembered. For example, reviewing photographs of previously encoded events increases subsequent memory accuracy relative to conditions where no photographic review occurs (Finley, Brewer, & Benjamin, 2011; Koutstaal, Schacter, Johnson, Angell, & Gross, 1998; Schacter, Koutstaal, Johnson, Gross, & Angell, 1997; St Jacques & Schacter, 2013). However, reviewing photographs can also have detrimental effects on memory (e.g., Cinel, Cortis Mack, & Ward, 2018; Lindsay, Hagen, Read, Wade, & Garry, 2004; St Jacques & Schacter, 2013; Strange, Hayne, & Garry, 2008; Wade, Garry, Read, & Lindsay, 2002). Memory retrieval is an active process that can update memories but also contribute to biases and other distortions when new information presented during retrieval becomes confused with old information (Hupbach, Gomez, Hardt, & Nadel, 2007; St Jacques, Olm, & Schacter, 2013) (for review see Schacter, Guerin, & St. Jacques, 2011). Thus, while photographs can boost the effects of rehearsal to maintain veridical memories they might also portray events in novel ways that could alter memories. For example, Henkel and Miliken (2020) demonstrated that reviewing edited photographs that were cropped compared to unedited photographs reduced the accuracy of visual information participants subsequently recalled.

Third-person photographs naturally depict novel visual perspective from how events were originally experienced by the rememberer. Vantage point is related to how people take photographs (Barasch, Zauberman, & Diehl, 2018; Chisholm et al., 2014). For example, Barasch et al. (2018) found that people who took photographs of events to sharing with others were more likely to adopt an observer perspective when recalling these same events several weeks

later. Vantage point in photographs can also bias how people think about events (for review see Libby & Eibach, 2011a). For example, Shaeffer, Libby, and Eibach (2009) presented participants with either first-person or third-person photographs of actions of other people (e.g., a hand wiping up a spill). After priming with first-person photographs, participants were more likely to endorse subsequent actions as concrete (e.g., making a list involves writing things down), whereas priming with third-person photographs led people to think of the same actions in a more abstract way (e.g., making a list involves getting organized). Other studies have shown that seeing oneself in a photograph (e.g., Bredart, Delchambre, & Laureys, 2006; Liu et al., 2015) or in a video (e.g., Robins & John, 1997) increases attention directed to the image of the self, which could potentially reduce the effectiveness some third-person photographs as retrieval cues.

Previous studies have used both first-person (Chow & Rissman, 2017) and third-person (Wade et al., 2002) photographs to test memory, but only a couple of studies have compared vantage point during photographic review of memories (Marcotti & St Jacques, 2018; St Jacques & Schacter, 2013). In one study, Marcotti and St. Jacques (2018) developed a mini-events paradigm (similar to McIsaac & Eich, 2002), in which participants engaged in a series of hands on events encoded from an own eyes perspective. During repeated memory retrieval two days later, participants were cued with a first-person photograph that was identical to the participant's original own eyes perspective, or a third-person photograph that showed the event from a novel vantage point located 180° in front of where the participant originally sat during the task. Participants were instructed to retrieve the memory from the viewpoint shown in the photograph (i.e., own eyes or observer-like perspective). Two days later, participants

were tested on their memory for events using a cued-recall task. The results indicated that subsequent memory accuracy was higher for memories that were retrieved using the photographs, when compared to a baseline condition with no photograph review. Critically, however, accuracy was also higher for memories that were cued by first-person compared to third-person photographs. In a second study, Marcotti and St. Jacques (2008) showed that similar effects on memory accuracy due to visual perspective using verbal descriptions of the events instead of photographic cues, suggesting that the key factor influencing subsequent memory accuracy were instructions to adopt a novel perspective during retrieval rather than differences in the nature of the photographic cues. These findings are consistent with previous studies demonstrating that instructing participants to actively shift visual perspective influences subsequent memory (for review see St. Jacques, 2019). In contrast, St. Jacques and Schacter (St Jacques & Schacter, 2013; study 2) manipulated whether photographs shown during memory retrieval depicted an identical or novel viewpoint compared to memory encoding during a museum tour. The novel viewpoint of photographs in this study were taken from a third-person perspective, but did not include the participant in the images. They found higher subsequent memory accuracy following photograph review from an identical perspective when compared to a novel perspective from how events were originally encoded. However, in this study participants were not instructed to actively shift their visual perspective by adopting the alternative viewpoint shown in the photographs. Instead, reductions in the sense of re-experience during retrieval cued by photographs showing an alternative perspective that mismatched the original encoding viewpoint was sufficient to reduce later memory accuracy.

No studies to date have examined how passively viewing photographs might differentially bias later memory retrieval when compared to active instructions to adopt a particular viewpoint shown in a photograph. On the one hand, instructions to actively retrieve memories from a novel perspective might produce greater effects in subsequent memory, than passive review from the same perspective, because it allows for greater integration between the original event and the novel visual perspective presented during retrieval (Chan, Meissner, & Davis, 2018). Supporting this idea, previous research has suggested that active versus passive retrieval optimizes learning (e.g., Roediger & Karpicke, 2006) and contributes to reactivation-related updating in memory (Bridge & Voss, 2014). On the other hand, the evidence reviewed above demonstrates that passive review of photographs can also have powerful effects on subsequent memory. Given the prevalence of photograph review in daily life (Henkel, Nash, & Paton, 2021), it is important to understand how passive review of third-person photographs influences subsequent memories and whether it differs from active instructions to retrieve memories from a novel viewpoint as typically used in laboratory studies.

Viewing third-person photographs could bias both the visual and spatial perspective of the remembered event. Visual and spatial perspective are typically used to distinguish between different types of perspective-taking or the ability to adopt another person's viewpoint (e.g., Clinton, Magliano, & Skowronski, 2018; Michelon & Zacks, 2006; Surtees, Apperly, & Samson, 2013), where visual perspective refers to the line of sight of the other person's perspective and spatial perspective refers to understanding where objects are placed with respect to the other person's perspective and reflects a spatial transformation of the scene. These concepts are also useful to understand how adopting own eyes and observer-like perspectives during

remembering can influence memory. During memory retrieval, visual perspective refers to the line of sight of the rememberer in the retrieved event, which can either be aligned to where the rememberer originally experienced the event (typically own eyes) or from an observer-like perspective where the rememberer sees themselves in the memory. In contrast, spatial perspective refers to understanding how the remembered scene is spatially transformed (e.g., left/right location of objects) with respect to the rememberer's location or where they view the memory from in their mind's eye. Related to these ideas, memories also involve egocentric and allocentric frames of reference. Egocentric reference frames typically refer to the one-to-one relationship between where one is located with respect to objects in the environment, whereas, allocentric reference frames refer to the object-to-object relationships in the environment (Byrne, Becker, & Burgess, 2007). Theories of memory suggest that both own eyes and observer-like perspectives rely on egocentric reference frames because they are centered with respect to where the representation of the image of the physical self is located in the event (Rubin & Umanath, 2015) (but see Freton et al., 2014; Hebscher, Levine, & Gilboa, 2018). Thus, shifting to a novel perspective involves updating one's egocentric reference frame in order to see the remembered event from a novel vantage point and is linked to brain regions that support egocentric imagery in memory (St. Jacques, 2019).

Visual perspective during remembering is typically tested based on subjective ratings of own eyes and observer perspective. For example, Marcotti and St. Jacques (2018; study 1) found that reviewing photographs of observer-like perspectives reduced the extent to which participants reported adopting an own eyes perspective during subsequent memory retrieval. Similarly, shifting visual perspective from a dominant own eyes to an alternative observer

perspective during autobiographical memory retrieval decreased own eyes ratings and increased observer ratings during subsequent retrieval of memories from their naturally occurring perspective (Butler, Rice, Wooldridge, & Rubin, 2016; St. Jacques, Szpunar, & Schacter, 2017). How own eyes and observer-like perspectives influence spatial perspective has not been fully considered in the literature. There is some evidence that perspective during retrieval affects spatial aspects of memory more generally. For example, McIsaac and Eich (2002) found that adopting an observer compared to an own eyes perspective during free recall of events increased the frequency of details mentioned in narratives about the spatial relationship of objects (e.g., the teapot was to the left of the kettle). However, this effect was not replicated in subsequent research using the same paradigm (Eich, Nelson, Leghari, & Handy, 2009), nor in studies examining the accuracy spatial relations in narratives of stories (Bagri & Jones, 2009) or cued-recall (Marcotti & St Jacques, 2018). One reason may be that the variable of interest in these previous studies targeted allocentric spatial representations (i.e., object-to-object) rather than egocentric representations (i.e., self-to-object) that involve a change in spatial perspective.

To investigate the role of reviewing first-person and third-person photographs on visual and spatial perspectives in subsequent memory we used a paradigm similar to that of our previous study, in which participants encoded a series of hands-on mini-events (Marcotti & St Jacques, 2018). Here, we captured both first-person photographs and third-person photographs (with or without the self) of the mini-events during encoding. One week later, participants were asked to retrieve memories for the mini-events cued by first-person or third-person photographs. A novel aspect of the current study was that we also manipulated instructions to shift perspective during retrieval: a no-instructions group was asked to recall the mini-events while looking at the

photos, whereas an instructions group was asked to recall the mini-events while adopting the same own eyes or observer-like perspective as shown in the photographs. Two days later, we tested memory for all the mini-events, including baseline events that were not retrieved. We created a novel test of spatial perspective in which participants were asked to re-arrange photos of the objects used in the mini-events as they were initially presented to them in session one, and then coded the spatial memory accuracy of objects based on egocentric (i.e., with respect to the original location of the participant during memory encoding) and allocentric (i.e., with respect to other objects in the mini-event) measures. Following from our previous study (Marcotti & St Jacques, 2018), we predicted a reduction in subsequent cued-recall accuracy in memories cued by third-person photographs compared to first-person photographs during retrieval, as well as reductions in the tendency to adopt an own eyes perspective during subsequent remembering. A novel prediction was that third-person photographs should also decrease subsequent egocentric memory accuracy (i.e., inverting left and right of objects with respect to the original viewpoint during encoding), but have less effect on subsequent allocentric memory accuracy (i.e., absolute spatial location of objects). We also we predicted that active instructions to shift visual perspective during retrieval should lead to overall stronger effects on subsequent memories (i.e., greater reductions for third-person versus first-person photographs) compared to passive photograph review. Finally, we examined potential differences in the nature of third-person photographs in which the self was present or absent. If third-person photographs including the self are distracting (e.g., Bredart et al., 2006; Liu et al., 2015), and thus, less effective retrieval cues, they should lead to a greater reduction in subsequent cued-recall compared to third-person photographs in which the self is absent. However, including the self in third-person photographs might also increase the likelihood with which participants spontaneously reinstate their original

own eyes perspective (e.g., Tversky & Hard, 2009), thus, actually mitigating differences between first-person and third-person photograph review.

Method

Participants. Forty fluent English speakers were included in the experiment [29 women; mean age in years (M) = 21.67, SD = 3.27; mean years of education (M) = 16.10, SD = 1.86]. The majority of participants self-reported that they were right-handed (N = 38). A statistical power analysis was performed using an effect size based on our previous published study (Marcotti & St Jacques, 2018; Study 1, N = 20), which used a similar study design to compare the difference in subsequent memory accuracy during photographic review of first-person and third-person photographs and a baseline condition with no photographic review. We conducted an *a priori* power analysis for a repeated measures ANOVA in G*Power 3.1, using an effect size of η^2_p = .46, an alpha = .05, and a conservative power estimate = .95. The projected sample size is approximately N = 10 for this within group comparison on retrieval condition. However, given that we did not know the effect size for the potential between subject effects of instructions, nor the effect size for instruction group by retrieval condition interaction, we doubled this projected sample size within each group. Thus, our final sample size of 40 participants (20 per group). Participants reported no history of psychiatric and/or mental health impairments, were not taking any medication that could affect cognitive function and had normal or corrected to normal vision/hearing. The study was approved by the Cross Schools Research Ethics Committee at the University of Sussex, and participants provided written informed consent according to this protocol.

Procedure. The study procedure was similar to Marcotti and St. Jacques (2018) and involved three separate study sessions. In Session One, participants performed 32 mini-events

that involved interacting with small objects on a tray while guided through a series of steps by the experimenter (e.g., Create Play Doh: form a beach scene with playdoh and send a message; see Figure 1 and Appendix for additional examples of mini-events). Briefly, participants were shown a tray of objects and a title while the experimenter read a brief instruction lasting about 30 seconds. They were then guided to interact with the objects on the tray for about 2 minutes to complete the entire task while the experimenter read out the instructions for a second time. Participants also wore a ViconRevue camera (Vicon, Oxford, United Kingdom) at chest level, which automatically took a photograph every 15 s using a timer. An additional ViconRevue camera was placed on the desk in front of where the participant was sitting. Thus, during the mini-events procedure photographs from two camera views were taken for each participant: 1) a first-person perspective that mimicked the original own eyes viewpoint during memory encoding, and 2) from third-person perspective that showed the participant's face and upper half of their body as they were conducting the mini-event (see Figure 1). Although the ViconRevue does not capture eye or head movements, the unique fisheye lens captures a 120-degree view that would mimic the typical field of view of the wearer—particularly given that participants in this study were seated and interacted with the mini-event placed directly in front of them. Session One took approximately 1.5 hours.

Figure 1. *Examples of first-person and third-person photographs.* In the own eyes condition, participants were shown a first-person photograph that was identical to their original viewpoint during Session 1. In the observer conditions, participants were shown a third-person photograph located 180° in front of the original viewpoint. Third-person photographs either depicted the participant (Observer-Self) or an empty chair (Observer-No-Self).

In Session Two, approximately one week later [mean delay (M) = 6.59, SD = 1.05; range = 5 to 9 days], participants were asked to retrieve memories for a subset of the mini-events cued by the title and a first-person or third-person photograph of the mini-event. We also manipulated whether third-person photographs depicted the participant in the photograph or did not (i.e., an identical third-person perspective but showing an empty chair instead of the participant; see Figure 1). Each photo depicted the mini-event as it would have appeared at the start of the task during Session One, and participants were instructed to covertly recall the mini-event they had conducted in as much detail as possible. We also manipulated whether participants were provided with explicit instructions about adopting a particular visual perspective. One group was instructed to retrieve memories for the mini-events while looking at the photographs with no explicit instructions about adopting the visual perspective shown (i.e., no-instruction group). Another group was explicitly instructed to adopt the visual perspective shown in the photographs cued by the labels “own eyes” or “observer” (i.e.,

instruction group). Specifically, participants in the instruction group were told that if the instructions were “own eyes” then they should retrieve their memory for the mini-task as if seeing it again through their own eyes, whereas if the instructions were “observer” than they should retrieve their memory as if viewing it from the perspective of a spectator or observer watching themselves conducting the mini-event.

A total of 24 mini-events were shown during retrieval in Session Two (eight per each of the three perspective conditions: own eyes, observer-self, and observer-no-self), and the remaining eight mini-events that were not presented were used in a baseline condition to assess potential changes in memory over time. Mini-events assigned to each study condition were counterbalanced across participants. In contrast with our previous study using the mini-event paradigm (Marcotti & St Jacques, 2018), here we increased the amount of retrieval time per trial from 7.5 s to 12 s to provide with more time to retrieve each individual memory. Retrieval trials for each memory were repeated four times in an interleaved fashion. Photographic cues were presented for the entire duration of the retrieval trial. Immediately following each retrieval trial, participants were given 2.5 s to provide a number of subjective ratings of memory retrieval on 5-point scales (from 1 = low to 5 = high) including difficulty, emotional intensity, reliving, and vividness. Additionally, participants in the instruction group also rated how well they were able to maintain their visual perspective for comparison with our earlier findings. Session Two took approximately 1 hour.

In Session Three, two days later, memory accuracy for the mini-events was assessed using a cued-recall task. Participants were presented with the titles of all 32 mini-events and asked a total of 12 short-answer questions equally distributed among the categories: actions (e.g., How did you shape the playdough? Correct Answer: *with a cookie cutter*), sensations (e.g., What did

the playdough smell like? Correct Answer: *almond/marzipan*), visual details (e.g., What colour where the umbrellas? Correct Answer: *pink*), temporal order of the actions to complete the task (e.g., When did you add the starfish to the playdough? Correct Answer: *after adding the pebbles/before removing the gloves*). The cued-recall questions were created such that they would not provide the correct answers to other questions about the same mini-event. We coded the responses according to a strict criterion (e.g., How did you mix the make-up? Correct: *with a mascara brush*; Incorrect: *with a brush*) for determining accuracy identical to Marcotti and St. Jacques (2018)¹, and there was 100% agreement on the coding of the correct responses.

Following the short-answer questions for each mini-event, participants were asked to provide subjective ratings on a 7-point scale (from 1 = low to 7 = high) on the following memory characteristics: emotional intensity, the visual perspective from which they remembered the event, the extent to which the event was remembered from an own eyes perspective, the extent to which the event was remembered from an observers perspective, how accurate they felt their memory was (i.e., recalling all the details of the event exactly as they occurred), reliving, and vividness. We included separate ratings for own eyes and observer perspectives in order to capture these mutually independent effects (Rice & Rubin, 2009). We also included a more refined scale of visual perspective in which participants were also asked to categorize the height (e.g., above eye-level, eye-level, below eye-level), location (e.g., in front, alongside or directly behind yourself, as well as directly to your left, centre, or right), and distance (e.g., < 6 feet away, > 6 feet away) of the particular viewpoint associated with remembering (based on McDermott et al., 2015; Rice & Rubin, 2011).

¹ A more lenient coding approach showed similar effects, thus only analyses using the strict criteria are reported in detail here.

To assess the impact of visual perspective during retrieval on subsequent spatial memory, a novel test was created in which participants were asked to arrange the objects from the 32 mini-events as they were originally displayed during Session One. Participants were presented with a Microsoft PowerPoint slide showing a top-down photograph of an empty tray along with photographs of each of the individual objects used in that mini-event (see Figure 2). The title of each mini-event was presented at the top of the tray, where it was originally located during Session One. They were asked to arrange the objects on the tray as they were initially presented at the start of each mini-event during Session One. Spatial memory accuracy was calculated based on the percentage of objects correctly positioned on the tray separately for each mini-event according to two main types of spatial memory: 1) egocentric spatial memory, correct left/right placement on the tray with respect to the participant, and 2) allocentric spatial memory, correct placement with respect to nearby objects on the tray. Correct responses for each type of spatial memory were coded by the experimenter (PM). Reliability was determined through comparison with a second rater who scored 10% of the sample and was blind to the hypotheses and conditions in the study. A two-way mixed intraclass correlation (ICC) coefficient revealed a high degree of reliability between the raters. The average ICC for egocentric spatial memory was .87 with a 95% confidence interval between .82 and .91, and for allocentric spatial memory it was .93 with a 95% confidence interval between .91 and .95. Participants also completed questionnaires to assess individual differences in mental imagery, but these were not the main focus of the current study and are not included here. Session Three took approximately 2.5 hours.

Figure 2. *Spatial Memory Task.* (A) Participants were presented an empty tray along with a photograph of each individual object used in the mini-event, and asked to place the objects on the tray in the positions they appeared at the start of each trial in Session One. (B) Correct arrangements of objects on the tray. (C) An example of a participant's arrangement of objects on the tray. In this example, the mini pebbles, bottle and starfish are all placed correctly with respect to one another (allocentric memory), but there is a left to right error in their location on the tray with respect to the original location during Session One (egocentric memory).

Data Analysis. Jamovi (version 1.2.17.0) was used to run all statistical tests. Unless otherwise stated, all main analyses were conducted using mixed repeated measures ANOVAs, with retrieval condition (own eyes, observer-self, observer-no-self; including baseline in Session Three results) as the within-subjects factor, and group (no-instructions, instructions) as the between-subjects factor. Violations of sphericity were corrected using Greenhouse-Geisser and

post-hoc P-values were adjusted for multiple comparisons using Bonferroni's correction. All data is available at: <http://dx.doi.org/10.17632/6n2ccps2jk.2>.

Results

Session Two

Subjective Ratings. We first examined how the retrieval condition and group instructions influenced subjective ratings of difficulty, emotional intensity, reliving, and vividness during memory retrieval (for means and SDs see Table 1).

Table 1. Subjective Ratings in Session Two

	<u>Difficulty</u>	<u>PerspMain</u>	<u>Emotion</u>	<u>Reliving</u>	<u>Vividness</u>
No Instructions					
Own eyes	1.85 (.59)	n/a	2.83 (.72)	3.38 (.66)	3.38 (.68)
Observer-self	2.19 (.82)	n/a	2.77 (.62)	3.32 (.58)	3.50 (.67)
Observer-no-self	1.91 (.54)	n/a	2.84 (.65)	3.39 (.62)	3.39 (.67)
Instructions					
Own eyes	2.16 (.61)	3.62 (.80)	3.02 (.70)	3.48 (.55)	3.57 (.49)
Observer-self	2.28 (.61)	3.07 (.73)	2.81 (.76)	3.23 (.62)	3.33 (.68)
Observer-no-self	2.29 (.70)	2.99 (.83)	2.65 (.73)	3.13 (.60)	3.25 (.67)

Mean (SD); PerspMain = Perspective Maintenance

We also examined potential differences in the instruction group on subjective ratings of perspective maintenance. First, for difficulty ratings we found a main effect of retrieval condition, $F(2, 76) = 5.01$, $p = .009$, $\eta^2_p = .12$, reflecting less difficulty when retrieving memories in the own eyes condition ($M = 2.01$, $SD = .61$) compared to the observer-self condition ($M = 2.23$, $SD = .72$), $p_{adj} = .007$, but not in the observer-no-self condition ($M = 2.10$, $SD = .65$), $p_{adj} = .59$ (see Figure 3). There were no other main effects or interactions.

Figure 3. *Difficulty Ratings in Session Two.* There was a significant increase in difficulty ratings in the observer compared to the own eyes condition. Coloured circles reflect mean for each participant, black circles represent the mean within each condition, and error bars reflect the 95% CI. The Bonferroni adjusted p-value is shown.

We also examined the perspective maintenance ratings that were collected in the instruction group only. There was a significant main effect of retrieval condition, $F(1.32, 25.10) = 10.30$, $p = .002$, $\eta^2_p = .35$. Post-hoc tests indicated that it was easier to maintain the perspective indicated in the own eyes condition compared to both the observer-self, $p_{adj} = .003$, and observer-no-self, $p_{adj} < .001$, conditions, but there were no differences between the two observer conditions. Thus, participants found it easier to retrieve memories in the own eyes condition and reported that it was easier to maintain this perspective during retrieval when explicitly instructed to do so.

Turning to emotional intensity, there was a main effect of perspective condition, $F(2, 76) = 4.31$, $p = .017$, $\eta^2_p = .10$, reflecting higher emotional intensity ratings when retrieving memories in the own eyes condition ($M = 2.92$, $SD = .71$) compared to the observer-no-self

condition ($M = 2.75$, $SD = .69$), $p_{adj} = .020$, but not in the observer-self condition ($M = 2.79$, $SD = .68$), $p_{adj} = .10$. This main effect of perspective condition was qualified by a significant Retrieval Condition X Group interaction, $F(2, 76) = 4.33$, $p = .017$, $\eta^2_p = .10$. Follow-up analysis revealed that there were no significant differences in emotional intensity between the conditions in the no instructions group, but in the instructions group emotional intensity ratings were higher in the own eyes compared to the observer-no-self condition, $p_{adj} = .002$ (see Figure 4). For reliving ratings, there was a main effect of retrieval condition, $F(2, 76) = 3.28$, $p = .043$, $\eta^2_p = .08$, but there were no significant differences between the conditions after post-hoc Bonferroni correction. There were no significant effects for vividness ratings, nor any other main effects or interactions.

Figure 4. *Emotional Intensity Ratings in Session Two.* There was a significant reduction in emotional intensity ratings in the observer-no-self compared to the own eyes condition in the instruction group. Coloured circles reflect mean for each participant, black circles represent the mean within each condition, and error bars reflect the 95% CI. The Bonferroni adjusted p-value is shown.

In sum, these findings show that the presence of the self in third-person photographs increased the difficulty of retrieving memories from a novel perspective relative to the same perspective as encoding. In contrast, reductions in emotional intensity emerged only when participants were explicitly instructed to adopt an observer perspective during retrieval cued by third-person photographs that lacked the presence of the physical self. However, there were no reliable differences in reliving or vividness during retrieval of memories cued by first-person versus third-person photographs.

Session Three

Subsequent Cued-Recall Memory. To examine differences in subsequent memory accuracy between the perspective conditions we conducted a 4 (retrieval condition: own eyes, observer-self, observer-no-self, baseline) x 4 (category detail: physical actions, sensations, temporal order of actions, visual details) x 2 (group: no-instructions, instructions) repeated measure ANOVA on the proportion of items correctly recalled (for means and SDs see Table 2). There was a main effect of retrieval condition, $F(3, 114) = 14.82, p < .001, \eta^2_p = .28$, with a higher percentage of items correctly recalled in own eyes ($M = 34.21, SD = 12.04$), observer-self ($M = 35.92, SD = 13.29$), and observer-no-self ($M = 35.36, SD = 12.00$) conditions compared to baseline ($M = 27.85, SD = 10.54$), all $p_{adj} < .001$. The main effect of category detail was also significant, $F(3, 114) = 43.44, p < .001, \eta^2_p = .53$. Participants correctly recalled significantly more physical actions ($M = 41.78, SD = 15.20$) compared physical sensations ($M = 27.46, SD = 10.72$), temporal order of actions ($M = 30.42, SD = 10.79$) and visual details ($M = 33.68, SD = 10.36$), all $p_{adj} < .001$. Recall of visual details was also significantly higher compared to sensations, $p_{adj} < .001$. There were no other significant effects. Thus, subsequent memory accuracy was overall

better due to retrieval in Session Two, but there were no significant differences between adopting different perspectives during retrieval in Session Two.

Table 2. Subsequent Cued-Recall Accuracy

	<u>Cued-Recall</u>			
	<i>Actions</i>	<i>Sensations</i>	<i>Temporal</i>	<i>Visual</i>
No Instructions				
<i>Own eyes</i>	44.20 (18.88)	29.85 (10.01)	29.30 (12.35)	34.20 (10.51)
<i>Observer-self</i>	46.40 (18.56)	30.90 (10.48)	30.45 (14.30)	38.75 (11.55)
<i>Observer-no-self</i>	44.70 (16.98)	31.35 (10.79)	31.80 (9.89)	32.10 (14.48)
<i>Baseline</i>	33.25 (14.84)	20.45 (11.51)	26.75 (12.37)	25.75 (12.15)
Instructions				
<i>Own eyes</i>	43.45 (19.32)	24.90 (16.41)	31.60 (14.72)	36.15 (14.24)
<i>Observer-self</i>	45.90 (20.70)	28.45 (16.83)	30.50 (17.12)	36.00 (15.57)
<i>Observer-no-self</i>	41.35 (17.73)	29.40 (14.50)	34.25 (16.08)	37.95 (17.73)
<i>Baseline</i>	35.00 (16.43)	24.40 (12.03)	28.70 (12.27)	28.50 (14.27)
Mean % Correct (SD)				

Spatial Memory. To examine differences between the conditions in spatial memory accuracy we examined the proportion of objects correctly arranged on the tray according to allocentric and egocentric reference frames (for means and SDs see Table 3). We conducted a 4 (retrieval condition: own eyes, observer-self, observer-no-self, baseline) x 2 (spatial memory: egocentric, allocentric) on the percentage of correct responses. There was a significant main effect of spatial memory, $F(1, 38) = 1578.08, p < .001, \eta^2_p = .98$, which was reflected by a greater percentage of correct responses for egocentric ($M = 70.13, SD = 9.95$) compared to allocentric ($M = 40.82, SD = 9.91$) spatial memory. There was also a significant main effect of retrieval condition, $F(3, 114) = 12.67, p < .001, \eta^2_p = .25$. Post-hoc analyses indicated that there was a greater proportion of correct responses in the own eyes ($M = 60.47, SD = 13.92$) compared to the observer-self ($M = 55.46, SD = 10.91$), $p_{adj} = .009$, observer no-self ($M = 55.01, SD = 10.73$), $p_{adj} = .009$, and baseline ($M = 50.97, SD = 9.16$), $p_{adj} = .009$, conditions (see Figure 5).

Additionally, there was a greater percentage of correct responses in the observer-self compared to the baseline condition, $p_{adj} = .03$, but the difference between the observer no-self and baseline conditions did not meet our threshold for significance after Bonferroni's correction, $p_{adj} = .06$. There were no interactions or other main effects. In sum, reviewing third-person compared to first-person photographs decreased subsequent spatial memory accuracy overall, but did not differentially affect allocentric or egocentric memory.

Table 3. Subsequent Spatial Memory

	<u>Allocentric</u>	<u>Egocentric</u>
No Instructions		
<i>Own eyes</i>	44.82 (9.04)	74.82 (11.01)
<i>Observer-self</i>	39.71 (9.24)	70.00 (9.01)
<i>Observer-no-self</i>	39.76 (9.47)	68.16 (9.26)
<i>Baseline</i>	32.58 (12.29)	66.09 (7.89)
Instructions		
<i>Own eyes</i>	47.42 (19.15)	74.80 (16.76)
<i>Observer-self</i>	43.43 (12.20)	68.71 (15.42)
<i>Observer-no-self</i>	40.81 (13.00)	71.30 (14.54)
<i>Baseline</i>	38.02 (10.63)	67.20 (8.80)
Mean % Correct (SD)

Figure 5. *Subsequent Spatial Perspective Accuracy.* There was a significant increase in spatial memory accuracy for objects in the own eyes conditions compared to both observer conditions and baseline. There was also a significant increase in spatial memory accuracy in the observer-self condition compared to baseline. Coloured circles reflect mean for each participant, black circles represent the mean within each condition, and error bars reflect the 95% CI. The Bonferroni adjusted p-value is shown.

Subjective Ratings. We first examined differences in subjective ratings separately for emotional intensity, reliving, vividness, and accuracy (for means and SDs see Table 4). There were main effects of retrieval condition on emotional intensity ($F(3, 114) = 9.18, p < .001, \eta^2_p = .19$), reliving ($F(3, 114) = 12.35, p < .001, \eta^2_p = .25$), vividness ($F(3, 114) = 22.21, p < .001, \eta^2_p = .37$) and accuracy ratings ($F(3, 114) = 21.84, p < .001, \eta^2_p = .36$). Follow-up analyses indicated that all of these main effects were explained by higher ratings in the own eyes, observer-self and observer-no-self conditions compared to baseline, all $p_{adj} < .001$. There were

no other main effects or interactions. Thus, memories retrieved during Session Two were overall associated with higher emotional intensity, vividness, reliving and perceived accuracy compared to memories that were not retrieved.

Table 4. Subjective Ratings in Session Three

	<u>Emotion</u>	<u>Reliving</u>	<u>Vividness</u>	<u>Accuracy</u>	<u>Own Eyes</u>	<u>Observer</u>
No Instructions						
	3.34	4.24	4.08	3.72	4.78	2.16
<i>Own eyes</i>	(1.43)	(0.98)	(0.89)	(0.71)	(1.09)	(1.03)
	3.37	3.93	3.98	3.66	4.78	2.19
<i>Observer-self</i>	(1.24)	(0.85)	(0.77)	(0.83)	(1.09)	(1.00)
	3.45	4.11	4.03	3.68	4.71	2.40
<i>Observer-no-self</i>	(1.25)	(0.97)	(0.89)	(0.78)	(1.12)	(1.08)
	2.88	3.55	3.27	2.93	4.46	1.85
<i>Baseline</i>	(1.15)	(1.07)	(0.78)	(0.86)	(1.23)	(0.76)
Instructions						
	3.46	4.04	4.13	3.79	5.08	1.82
<i>Own eyes</i>	(1.21)	(1.14)	(1.06)	(1.06)	(1.29)	(0.72)
	3.40	3.94	4.03	3.65	5.08	2.34
<i>Observer-self</i>	(1.09)	(1.18)	(1.12)	(0.96)	(1.29)	(1.04)
	3.30	3.78	4.05	3.68	4.54	2.26
<i>Observer-no-self</i>	(1.34)	(1.30)	(1.09)	(1.03)	(1.43)	(1.16)
	2.86	3.41	3.42	3.18	4.78	1.78
<i>Baseline</i>	(1.08)	(1.15)	(1.00)	(0.86)	(1.36)	(0.72)
Mean (SD)						

Next, we examined whether the experimental manipulation in Session Two influenced the spontaneous use of own eyes and observer visual perspectives in Session Three. We conducted a 2 (perspective rating: own eyes, observer) x 4 (retrieval condition: own eyes, observer-self, observer-no-self, baseline) x 2 (group: instructions, no instructions) repeated measures ANOVA. We found main effects of perspective rating, $F(1, 38) = 107.73, p < .001, \eta^2_p = .74$, and retrieval condition, $F(3, 114) = 5.66, p = .001, \eta^2_p = .13$. However, these were qualified by a significant Perspective Rating x Retrieval Condition interaction, $F(2.23, 84.68) = 3.29, p = .037, \eta^2_p = .08$. Post-hoc analyses indicated that there were no significant differences between the perspective

conditions on own eyes ratings. In contrast, observer ratings were higher in the observer-self ($M = 2.27$, $SD = 1.01$) compared to the baseline ($M = 1.81$, $SD = .73$) condition, $p_{adj} = .041$, and between the observer-no-self ($M = 2.33$, $SD = 1.11$) and baseline conditions, $p_{adj} = .009$ (see Figure 6). However, there was no significant difference in observer ratings between the own eyes ($M = 1.99$, $SD = .90$) and baseline condition. Thus, these findings show that although memories were equally rated on own eyes ratings across the retrieval conditions, adopting a novel perspective during retrieval increased the degree to which participants adopted an observer perspective during later memory retrieval.

Figure 6. *Subsequent Visual Perspective Ratings.* (A) There was no significant difference in subsequent own eyes ratings among the conditions. (B) Subsequent observer ratings were higher in both the Observer-Self and Observer-No-Self conditions when compared to Baseline. Coloured circles reflect mean for each participant, black circles represent the mean within each condition, and error bars reflect the 95% CI. The Bonferroni adjusted p-value is shown.

Spatial Location of Observer Perspectives. We also examined potential differences in the spatial location of the observer perspective according to height, location, and distance. As a first step, we categorized memories on these dimensions according to one of three perspectives based on McDermott et al. (2016): 1) *own eyes perspective*, if participants rated it as “own eyes” on both the distance and location categories, b) *observer perspective*, if it was not rated as “own eyes” on both the distance and location categories or “other” category on either height or location categories, or c) *other perspective*, if it was rated as “other” on both height and location categories. A non-parametric Friedman’s test was used to examine potential differences in the frequency of memories within these perspective categories separately within each group and retrieval condition, and pairwise comparisons were conducted with Durbin-Conover tests using a Bonferroni correction for multiple comparisons. If the separate within group or retrieval condition effects did not reveal significant differences in the overall pattern, then we report the overall results collapsed across group and retrieval condition. Turning to those results, we found a significant difference in the percentage of memories categorized according to perspective, $\chi^2(2) = 57.15, p < .001$. Pair-wise comparisons indicated that a greater percentage of memories were retrieved from an own eyes perspective (66.7%) than an observer perspective (31.5%), which were both more frequent than the other perspective category (1.8%), all p ’s $< .001$ (for frequencies see Supplemental Table).

Next, we examined the spatial location of the subset of memories that were identified as observer perspectives.² We conducted separate analyses for height (above eye-level, eye-level, below eye-level), distance (< 6 feet away, > 6 feet away), location front/back (alongside, in front, behind), location side/body (right, centre, left; based on McDermott et al., 2015; for frequencies

² Logically, memories classified as own eyes do not have remembered viewpoints at multiple spatial locations. We did not examine memories classified in the other perspective category given the low number of memories.

see Table 5), using the same non-parametric analysis strategy as above unless indicated. First turning to height, we found a significant difference overall, $\chi^2 (2) = 7.02, p = .03$, with a greater frequency of observer perspectives located above (41.9%) than below eye-level (30.0%), $p = .009$, but no differences from eye-level (33.4%). For distance, we also found a significant difference overall, $\chi^2 (1) = 34.00, p < .001$, with a greater frequency of observer perspectives located at a distance of less 6 feet away (97.1%) compared to a distance greater than 6 feet away (2.9%).

Table 5. Observer Perspective Location in Session Three

	<u>No Instructions</u>				<u>Instructions</u>			
	OE	OB-Self	OB-No-Self	Baseline	OE	OB-Self	OB-No-Self	Baseline
<i>Height</i>								
above eye-level	49.3%	37.9%	50.8%	43.7%	32.0%	39.3%	47.5%	34.5%
eye-level	27.7%	36.0%	30.3%	41.7%	39.8%	34.9%	27.2%	36.3%
below eye-level	23.0%	26.1%	18.9%	14.6%	28.2%	25.8%	25.3%	29.2%
<i>Distance</i>								
< 6 feet away	92.8%	97.3%	95.2%	96.9%	100.0%	97.8%	92.4%	100.0%
> 6 feet away	7.2%	2.7%	4.8%	3.1%	0.0%	2.2%	7.6%	0.0%
<i>Location Side/Body</i>								
right	23.7%	37.3%	31.1%	30.7%	11.4%	3.6%	7.1%	4.2%
centre	70.6%	52.6%	64.9%	58.9%	88.6%	96.4%	91.6%	92.1%
left	5.8%	10.2%	3.9%	10.4%	0.0%	0.0%	1.2%	3.7%
<i>Location Front/Back</i>								
in front	57.6%	55.5%	44.3%	39.4%	45.6%	74.1%	75.4%	55.3%
alongside	16.9%	23.1%	36.1%	28.4%	24.8%	17.4%	16.9%	32.4%
behind	25.5%	21.3%	19.6%	32.3%	29.6%	8.5%	7.7%	12.4%

% Frequency of Observer Perspectives; OE = Own Eyes, OB = Observer

Turning to location, there were significant differences in the frequency of observer perspectives according to the location side/body category overall, $\chi^2 (2) = 33.45, p < .001$. Pairwise comparisons indicated that a greater frequency of observer perspectives were in the centre (76.5%) than either the left (3.6%) or right (19.9%) side, p 's $< .001$. However, the

difference between left and right was above our threshold for significance after Bonferroni correction for multiple comparisons, $p = .03$. We conducted an additional analysis examining the observer-self and observer-no-self conditions separately within each group because visual inspection indicated a striking difference in the frequency of the location side/body category in the observer conditions across the groups (see Table 3). In the instruction group, we found a significant difference in location side/body (observer-self: $\chi^2(2) = 28.20, p < .001$; observer-no-self: $\chi^2(2) = 22.43, p < .001$), which reflected a greater frequency of observer perspectives located in the centre than either the left or right side, both p 's $< .001$. In the observer-no-self condition, there was also a significant increase in perspectives located on the right than left side, $p = .003$. In the no-instruction group, there was a significant difference in the location side/body category in the observer-no-self condition, $\chi^2(2) = 12.58, p = .002$, but not in the observer-self condition, $\chi^2(2) = 4.94, p = .09$. In the observer-no-self condition, there was a greater frequency for centre compared to left, $p < .001$, but the difference between centre and right side was above our threshold for significance after Bonferroni correction for multiple comparisons, $p = .02$.

There were also significant differences in the frequency of observer perspectives according to the location front/back category in the instruction group, $\chi^2(2) = 15.19, p < .001$, but not in the no-instruction group, $\chi^2(2) = 3.76, p = .15$. Pairwise comparisons within the instruction group indicated that a higher percentage of observer perspectives were located in front (66.1%) when compared to behind (14.1%) or alongside (19.8%), both p 's $< .001$. Separate analyses within each retrieval condition also revealed significant differences in the frequency of observer perspectives according to location front/back in both the own eyes, $\chi^2(2) = 7.93, p = .019$, observer-self, $\chi^2(2) = 17.01, p < .001$, and observer-no-self, $\chi^2(2) = 14.20, p < .001$, conditions, but not the baseline condition, $\chi^2(2) = 3.95, p = .138$. Pairwise comparisons revealed that in the

experimental conditions, conditions there was a greater frequency of observer perspectives located in front (own eyes condition = 51.6%; observer-self condition = 64.8%, observer-no-self condition = 58.8%) compared to alongside (own eyes condition = 20.8%; observer-self condition = 20.3%, observer-no-self condition = 27.1%), all p 's < .01. However, in the observer conditions only the frequency of observer perspectives located in front was also greater than those located behind (own eyes condition = 27.6%; observer-self condition = 14.9%, observer-no-self condition = 14.1%), both p 's < .001.

In sum, these findings suggest that observer perspectives tended to be located in a similar location to the viewpoint shown in the third-person photograph: within 6 feet, at centre, and 180° in front of the original viewpoint. Observer perspectives located in centre were more frequent in the observer conditions when participants were given instructions or when cued by photographs without the presence of the self. Additionally, observer perspectives located in front of the self were more frequent in the observer than own eyes retrieval conditions and when participants were provided with instructions to adopt the perspective in the photograph or for memories that had been previously cued with a photograph showing this identical observer perspective. Thus, these more nuanced analyses of visual perspective demonstrate subtle differences in where the observer viewpoint was located within the remembered scene.

Discussion

The current study demonstrates that first-person and third-person photographs during photographic review can bias subsequent memories—even without active instructions to adopt the particular viewpoint shown. Third-person photographs influenced both the visual perspective and the spatial perspective of subsequent memories, as indicated by higher observer ratings and fewer correct responses on spatial memory when compared to review of first-person

photographs. Instructions to actively adopt the third-person perspective shown during photographic review, however, did increase the frequency with which the identical viewpoint shown in the photograph was naturally adopted during subsequent remembering. Perspective instructions also reduced emotional intensity during memory retrieval cued by third-person photographs in which the self was absent from the image compared to first-person photographs, but these effects did not persist when memories were subsequently remembered. The findings of the current study provide novel evidence about the important role of viewpoint during photographic review of memories.

Viewing third-person photographs influenced the visual perspective adopted in subsequent memories as reflected by an increase in observer ratings compared to events that had not been retrieved, along with an increased tendency to adopt the identical third-person perspective shown in the photograph. Previous research has shown that actively shifting from an own eyes to an observer perspective increased the tendency to adopt an observer perspective during subsequent remembering (Butler et al., 2016; Marcotti & St Jacques, 2018; St. Jacques et al., 2017). Here, we found that shifting to an observer perspective increased observer but not own eyes ratings. These findings support the independent framework of visual perspective (Rice & Rubin, 2009), in which own eyes and observer perspectives are not viewed as mutually exclusive nor endpoints of a continuum. Participants reported higher observer ratings during subsequent remembering irrespective of earlier retrieval instructions to adopt the viewpoint shown, suggesting that passively seeing alternative viewpoints during photograph review is sufficient to bias visual perspective in later memory. Additionally, the presence of the self in third-person photographs did not influence whether people later reported adopting an observer perspective, suggesting that changes in subsequent visual perspective ratings were not a simple case of demand

characteristics. If participants were simply recalling the identical viewpoint from the photograph due to expectations about the nature of the study, then they should have also reported higher observer ratings (i.e., seeing themselves from the alternative viewpoint) in memories where they had also seen themselves during photographic review versus memories in which they had not seen themselves.³ Although instructions to adopt the viewpoint shown and the presence of the self in photographs did not influence the overall tendency to adopt an observer perspective during subsequent remembering, these manipulations did influence *where* the observer perspective was located such that participants were more likely to report that they adopted an observer perspective identical to the one in the photograph (i.e., located in centre and in front of the original viewpoint). Previous studies have demonstrated that observer perspectives in memories can be located at multiple locations in space (McDermott et al., 2016; Rice & Rubin, 2011). Here we show that third-person photographs can influence where this observer perspective will be located. The third-person photographs used here all depicted an identical location, but it would be of interest for future research to manipulate the potential location of the observer perspective in the photographs.

Reviewing third-person photographs of memories for events not only changed where the rememberer was located, but also the spatial location of objects in the remembered event. Our findings extend earlier research suggesting a link between observer perspectives and spatial details in memories for events (e.g., McIsaac & Eich, 2002). Research from spatial memory has demonstrated that actual or imagined movement in space updates egocentric information such that the relationships of objects with respect to the self is changed (Byrne et al., 2007), as well as

³ Although it is possible there were potential cross-over effects that mitigated the within subject manipulation of the presence or absence of the self in third-person photographs.

evidence that allocentric information is preserved when novel perspectives are parallelly aligned (i.e., 180°) to the initial study location (e.g., Mou & McNamara, 2002; Mou, McNamara, Valiquette, & Rump, 2004). However, contrary to our prediction, we did not find that visual perspective preferentially affected egocentric versus allocentric aspects of remembered events. One reason might be that the interactive nature of the objects used in the mini-events paradigm limited the ability to distinguish between egocentric and allocentric aspects of spatial memory. Although participants viewed the objects during encoding from a starting position that was identical to the photographic retrieval cues, they also manipulated the objects in various ways that moved them to novel spatial locations during encoding. Future research might better understand the influence of adopting alternative perspectives on egocentric versus allocentric aspects of spatial memory by using static objects. Although we found that adopting an observer versus an own eyes perspective during retrieval impaired spatial aspects of subsequent memory, there might be some circumstances in which adopting an observer viewpoint could enhance spatial aspects of memory. For example, Iriye and St. Jacques (2021) found that memories formed from a third-person avatar perspective during immersive virtual reality were associated with greater accuracy for the spatial layout of the virtual environment, which they linked to the ability to perceive more of the surroundings when viewing the scene from a distance with respect to the location of their avatar. The mini-events used in the current study restricted the focus in memory to objects located on a tray and thus limited the potential to investigate the role of third-person perspectives on memory for the surroundings.

A related line of research has shown that the presence of other people or avatars in photographs influences spatial perspective (David et al., 2006; Furlanetto, Cavallo, Manera, Tversky, & Becchio, 2013; Samson, Apperly, Braithwaite, Andrews, & Bodley Scott, 2010;

Tversky & Hard, 2009). For example, Tversky and Hard (2009) asked participants to report the spatial relations of objects presented in a photograph. When a person was included in the photograph participants were more likely to describe the spatial relations of objects from the other person's point of view relative to their own but adopted their own perspective instead when the other person was not present, suggesting that participants spontaneously took a perspective different from their own and reversed the left and right spatial location of objects. Thus, the mere presence of another person in a photograph determined whether participants adopted their own or another person's perspective. Further, Cavallo, Ansuini, Capozzi, Tversky, and Becchio (2017) showed that participants spontaneously adopted a perspective different from their own even when there was a mere possibility of another viewpoint such as if the person in the scene was replaced with an empty chair. In the current study we found that third-person photographs including the self in the image led to an increase in subsequent spatial memory when compared to baseline events that were not retrieved, but this was not sufficient to mitigate reductions in spatial memory when compared to the own eyes condition. Here the third-person photographs depicted events in which the participant had experienced the alternative viewpoint, involving memory rather than perception of a novel viewpoint on a scene, and an egocentric (i.e., self) rather than an altercentric (i.e., other) perspective. Additionally, there are reported differences in how people automatically adopt alternative spatial perspectives during perception of others versus personally experienced memories (St. Jacques, Conway, Lowder, & Cabeza, 2010).

We found isolated effects of third-person photographs on the emotional intensity of memories despite the minimal level of emotion associated with the mini-events. In particular, there was a reduction in emotional intensity when participants were instructed to adopt the third-person than first-person perspective shown in the photograph, but only when the image of the

self was absent. A number of studies have shown that actively shifting from an own eyes to an observer perspective reduces the emotional intensity of remembering (for review see Wallace-Hadrill & Kamboj, 2016), and can sometimes persist over time (Sekiguchi & Nonaka, 2014). Our findings support this research but also show that active retrieval processes involved in shifting to a novel viewpoint are critical for regulating emotions during retrieval. It is interesting that the impact of shifting visual perspective on emotion did not extend to third-person photographs including the self, as these might have been expected to represent the canonical version of an observer perspective. One explanation is that including the self in the third-person perspective photograph was distracting for memory retrieval (e.g., Bredart et al., 2006; Liu et al., 2015). Supporting this idea, difficult ratings were higher when retrieving memories cued by third-person photographs including the self. At any rate, better understanding the impact of the self in photographs has important implications for considering the role of visual perspective in emotional regulation (Webb, Miles, & Sheeran, 2012) if seeing the self in the photograph could potentially protect memories from changes in emotion due to shifting visual perspective. Moreover, the current findings support other evidence demonstrating that shifting from an own eyes to an observer perspective does not necessarily reduce emotional intensity in all memories (Libby & Eibach, 2011b; Sutin & Robins, 2008), but also depends on nature of the visual perspective during memory retrieval as shown here.

Although photographic review improved subsequent memory cued-recall accuracy when compared to a baseline no-review condition, there were no significant differences in subsequent cued-recall accuracy for memories cued by first-person or third-person photographs as we showed previously (Marcotti & St Jacques, 2018). One reason may be due to the lack of differences in subjective ratings of reliving and vividness during retrieval between memories

cued by first- person or third-person photographs. The intensity of reactivation based on subjective reports of reliving during memory retrieval has been shown to influence the degree of changes in subsequent memory accuracy (St Jacques et al., 2013; St Jacques & Schacter, 2013). Similarly, in our previous study we found that differences in vividness ratings when adopting an observer-like perspective during memory retrieval contributed to reductions in subsequent memory accuracy on cued-recall (Marcotti & St Jacques, 2018). According to the nonmonotonic plasticity hypothesis (for review see Sinclair & Barense, 2019), there is a “sweet spot” for the intensity of memory reactivation that determines the malleability of memories due to retrieval. The current study might not have hit the right level of memory reactivation to lead to changes in subsequent cued-recall, despite the significant effects on visual and spatial perspective. There were also other methodological differences between the current and previous studies that could have contributed to the lack of the effect here. For example, in the current study the duration of memory retrieval was also increased from 7.5 to 12 s (Marcotti & St Jacques, 2018; St Jacques & Schacter, 2013). Iriye and St. Jacques (2020) found that visual perspective largely impacts retrieval processes that occur earlier rather than later (i.e., within 2.5 s). Thus, by allowing more time for memory retrieval we could have inadvertently minimized the effects of viewpoint as participants had additional time to elaborate upon memories.

Understanding more generally how visual perspective during remembering influences the accuracy of memory has important implications in eyewitness testimony. For example, the cognitive interview technique, employed in forensic settings to elicit more accurate memories, involves a shift in perspective in which people are instructed to adopt an altercentric perspective (Geiselman, 1984). These findings are based on the classic study by Anderson and Pichert (Anderson & Pichert, 1978) in which participants encoded a narrative from a particular

perspective and then were asked to shift their perspective in order to recall additional details about the narrative. These findings suggest that shifting visual perspective could increase the accuracy of memories in certain circumstances, which differs from the current study and other research showing that adopting an alternative perspective reduces memory accuracy (Bagri & Jones, 2009; Marcotti & St Jacques, 2018). However, one important difference is that in the current study participants are asked to adopt an alternative perspective on their initial retrieval attempt, rather than taking a novel perspective with the aim of recovering additional details on a later retrieval attempt. Better understanding the theoretical and methodological differences that contribute to changes in memory accuracy due to visual perspective is an important future direction.

Conclusion. This study investigates for the first time the influence of first-person and third-person perspectives during photographic on subsequent memory. We found that third-person photographs influenced both the visual and spatial perspective of subsequent memories, by increasing self-reports of observer perspectives and reducing spatial memory accuracy for the location of objects with respect to the original viewpoint during encoding. With the increase in the number of photographs we take and upload every day on social networks and, in particular, the increase in the number of ‘selfies’, the current study highlights the importance of examining the role of third-person photographs on memory.

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Figures

Figure 1. *Examples of first-person and third-person photographs.* In the own eyes condition, participants were shown a first-person photograph that was identical to their original viewpoint during Session 1. In the observer conditions, participants were shown a third-person photograph located 180° in front of the original viewpoint. Third-person photographs either depicted the participant (Observer-Self) or an empty chair (Observer-No-Self).

Figure 2. *Spatial Memory Task.* (A) Participants were presented an empty tray along with a photograph of each individual object used in the mini-event, and asked to place the objects on the tray in the positions they appeared at the start of each trial in Session One. (B) Correct arrangements of objects on the tray. (C) An example of a participant's arrangement of objects on the tray. In this example, the mini pebbles, bottle and starfish are all placed correctly with respect to one another (allocentric memory), but there is a left to right error in their location on the tray with respect to the original location during Session One (egocentric memory).

Figure 3. *Difficulty Ratings in Session Two.* There was a significant increase in difficulty ratings in the observer compared to the own eyes condition. Coloured circles reflect mean for each participant, black circles represent the mean within each condition, and error bars reflect the 95% CI. The Bonferroni adjusted p-value is shown.

Figure 4. *Emotional Intensity Ratings in Session Two.* There was a significant reduction in emotional intensity ratings in the observer-no-self compared to the own eyes condition in the instruction group. Coloured circles reflect mean for each participant, black circles represent the mean within each condition, and error bars reflect the 95% CI. The Bonferroni adjusted p-value is shown.

Figure 5. *Subsequent Spatial Perspective Accuracy.* There was a significant increase in spatial memory accuracy for objects in the own eyes conditions compared to both observer conditions and baseline. There was also a significant increase in spatial memory accuracy in the observer-self condition compared to baseline. Coloured circles reflect mean for each participant, black circles represent the mean within each condition, and error bars reflect the 95% CI. The Bonferroni adjusted p-value is shown.

Figure 6. *Subsequent Visual Perspective Ratings.* (A) There was no significant difference in subsequent own eyes ratings among the conditions. (B) Subsequent observer ratings were higher in both the Observer-Self and Observer-No-Self conditions when compared to Baseline. Coloured circles reflect mean for each participant, black circles represent the mean within each condition, and error bars reflect the 95% CI. The Bonferroni adjusted p-value is shown.

Appendix

Examples of the experimenter instructions and photographs of the mini-events in Session One.

1. Polish the Shoes: *Prepare the shoes with polish and do a trick.* Use the tweezers to remove the shoes from their boxes; put the shoes on top of the small display; open the clear plastic container with the polish; smell the polish; use the cotton bud to polish the blue shoes; remove the shoe brush from the tin foil; take the shoe brush and remove any excess polish from the blue shoes; place all the shoes on the miniature skateboard (with fingers is fine); press down on one end so the skateboard points up.

2. Frog Pond: *Free the frogs into the pond and feed them.* Unwrap the frogs from the tissue paper; drop the frogs one at a time on the drum; cover the drum with the fake lily pads; open the domino box; smell inside the box; use the dominoes to create a pond border; pull bits off the tissue paper and roll into insects; drop the insects onto the drum; tap the drum with the drumsticks to make the insects dance.

3. Fishing Expedition: *Collect the fish and prepare sushi.* Use the chopsticks to collect the fish from the blue cup; put the fake rice (the white sponge) on the fake seaweed (the green rectangles); place fish on top of the rice; roll up the sushi and fasten using a safety pin; now repeat for the sushi roll until all everything is made; smell the ginger in the plastic bag; take the ginger out and put it on the plate; put the sushi rolls on the plate; then announce dinner by swinging the rattle.

Supplemental Information

Supplemental Table. Frequency of Different Perspectives Based on Refined Scale

	<u>No Instructions</u>				<u>Instructions</u>			
	<i>OE</i>	<i>OB-Self</i>	<i>OB-No-Self</i>	<i>Baseline</i>	<i>OE</i>	<i>OB-Self</i>	<i>OB-No-Self</i>	<i>Baseline</i>
Own Eyes Perspective	65.6%	71.3%	63.4%	66.9%	71.9%	60.6%	61.9%	71.3%
Observer Perspective	31.3%	27.5%	34.4%	27.5%	27.5%	39.4%	36.9%	27.5%
Other Perspective	3.1%	1.3%	1.3%	5.6%	0.6%	0.0%	1.3%	1.3%

OE = Own Eyes, OB = Observer