Journal of Applied Research in Memory and Cognition

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Online First Publication, May 26, 2025. https://dx.doi.org/10.1037/mac0000230

Journal of Applied Research in Memory and Cognition

ISSN: 2211-3681

https://doi.org/10.1037/mac0000230

EMPIRICAL ARTICLE

A Photo-Taking Impairment Effect on Conceptual Inference: The Disruptive Effect of Taking Photos on Learning Abstract Categories

Belgin Ünal[1], Megan O. Kelly[2], and Aaron S. Benjamin[1, 3]
[1] Department of Psychology, University of Illinois Urbana-Champaign, United States
[2] Department of Psychology, University of Waterloo, Canada
[3] Beckman Institute for Advanced Science and Technology, University of Illinois Urbana-Champaign, United States

Recent articles have reported that photographed information is less likely to be remembered than non-photographed information. We tested the influence of taking photos on categorical inference. Participants studied paintings by artists; they photographed some artists' paintings and only observed other artists' paintings during study. Then, they identified the artists of the studied and new paintings. Participants were more accurate in identifying the artists of old and new paintings when they had observed the paintings at study *without* photographing them. This effect was found when observe-only and camera trials had equal study duration (E1) and when participants were given additional time to photograph the paintings after viewing (E2). The impairment was not observed when participants viewed the painting after photographing (E3), though we cannot draw causal conclusions about the effect of order since E2 and E3 were run separately. These results suggest that photographing interferes with the development of representations that underlie inference.

General Audience Summary

We might think that taking a picture of something is a good way of remembering it and learning from it. But in some cases, people remember less about objects that they photograph than about objects that they observe without photographing. Here, we examined how taking photographs affects category learning—the ability to make judgments about whether an object belongs to one class or another. In these experiments, people studied multiple paintings by a set of artists and later were asked to identify the artist of a set of paintings. During study, some artists' paintings were photographed, and others were not. People were more likely to correctly identify an artist if they had *not* photographed the artists' paintings at study than if they *had* photographed their paintings. This was true even for paintings that had not been studied. This effect was found when participants observed the painting before receiving additional time to take the photograph. The impairment effect on inference was not apparent when participants observed the painting after receiving additional time to photograph. We cannot draw causal conclusions about the timing of photographing and observing the painting on the photo-impairment effect, as these were tested in separate experiments; however, our results indicate that the impairment persists even when individuals are given additional time to photograph. Overall, these results suggest that taking photos interferes with the development of mental representations that help us to draw inferences about categories.

Keywords: photo-taking impairment, inference, memory, learning, category learning

Karl Szpunar served as action editor.

Belgin Ünal https://orcid.org/0000-0002-5720-953X

All data and analysis files have been made publicly available at the Open Science Framework and can be accessed at https://osf.io/se8j7/. The experiments were not preregistered.

The authors have no conflicts of interest to disclose. This research was conducted while Megan O. Kelly was a visiting scholar at the Human Memory and Cognition Laboratory, University of Illinois Urbana-Champaign, with support from a Michael Smith Foreign Study Supplement provided by the Natural Sciences and Engineering Research Council of Canada.

The authors thank members of the Human Memory and Cognition Laboratory at the University of Illinois Urbana-Champaign for their helpful comments and criticisms. The authors also thank Anagha Dangi, Joy Akindulureni, and Hector Shi for assistance with data collection for this project.

Belgin Ünal played a lead role in data curation, formal analysis, and writing–original draft and an equal role in conceptualization. Megan O. Kelly played a supporting role in formal analysis and writing–original draft and an equal role in conceptualization and writing–review and editing. Aaron S. Benjamin played a lead role in conceptualization and an equal role in writing–review and editing.

Correspondence concerning this article should be addressed to Belgin Ünal, Department of Psychology, University of Illinois Urbana-Champaign, 603 East Daniel Street, Champaign, IL 61820, United States. Email: bunal2@illinois.edu

Smartphones are a ubiquitous partner to human cognition. The vast majority of people own smartphones (91% of Americans; Pew Research Center, 2024); those people also always have a camera at their side. Given the ease of capturing photographs, it may be counterintuitive that the act of taking photographs appears to be detrimental for memory of the content of the images (Henkel, 2014), revealing a *photo-taking impairment effect*. In the current investigation, we extend the examination of this effect to the learning of categories by testing how taking photographs influences category learning performance.

Henkel (2014) provided the original demonstration of the photo-taking impairment effect. Her participants completed a guided museum tour; throughout that tour, participants attended to a series of objects, observing *and* photographing some objects and *only* observing others. The next day, participants were tested on their memory for the museum objects. Henkel found that participants recognized fewer photographed objects and recalled fewer details about the photographed objects. Since photographing could lead to observing the object for less time, an additional study was run in which observation time was equated between the photograph and observe-only conditions. The memory impairment remained even when to-be-photographed objects were given more total study time than other objects.

This counterintuitive finding might occur because taking a photograph carries the expectation of being able to access the external memory when needed and so elicits lesser efforts to encode the image into memory (the *offloading* hypothesis; Henkel, 2014). One interpretation of this claim is that, if a reliance on later access to photographs reduces remembering efforts at encoding, then knowing that one will not be able to access their photographs later should encourage intentional remembering efforts comparable to those in the observe-only condition and eliminate the memory deficit in the photograph condition. However, even when participants know that their photographs will be deleted, memory impairment remains (Soares & Storm, 2018). Soares and Storm (2018) proposed that the act of taking photos leads to disengagement from the object, possibly to physically and cognitively handle the action of taking a photograph and framing the image within the photograph (the *attention-disengagement* hypothesis).

These proposed mechanisms may not be mutually exclusive. Cognitive offloading may occur because taking a photo inadvertently creates a belief that the information is saved for future review, reducing the need to encode and freeing up resources for other cognitive activities. Additionally, photo-taking may also disrupt attentional processes by diverting attention from the scene to the task of capturing the image, thereby disengaging the photographer from fully processing the scene. To tease apart causes for this photo-taking impairment effect is beyond the scope of the current work, but it is worth considering those explanations in the broader context of the cognitive partnership between a human and an external device (Hamilton & Benjamin, 2019; Risko & Gilbert, 2016). Outsourcing the verbatim retention of an image to a device like a camera is a smart trade-off. Indeed, supporting memory with external aids allows the accurate "retrieval" of far more information than what is possible with internal memory alone across a variety of contexts (e.g., Dupre et al., 2024; Kelly & Risko, 2022). A modern camera in a smartphone can do a much better job of "remembering" images than a human can.

In contrast to a situation where one would outsource memory, a visit to a museum is not necessarily an opportunity to merely store a set of images, it is an opportunity to learn. One type of learning that is relevant in such a context is the learning of categories of artifacts or art. Drawing inferences across experiences and learning categories of events are a hallmark of human cognition. If the act of photographing can shift attention from one set of characteristics to another (Lurie & Westerman, 2021), then taking photographs might influence categorical knowledge as well as memory.

When photographs are taken with the goal of learning, the results on memory are different. Barasch et al. (2017) found a photo-taking *enhancement* when participants were able to choose which objects to photograph. Individuals likely chose to photograph objects of particular interest to them, so this outcome may reflect the beneficial effects of interest or expertise overwhelming the negative effect of photo-taking. In addition, it could be that individuals tend to take photos of the very objects that they would already be more likely to remember. This illustrates the role of metacognitive control in producing or eliminating memory impairment (cf. Benjamin, 2007; Fiechter et al., 2016).

Similarly, in an online lecture setting, Ditta et al. (2023) found a photo-taking enhancement: Participants remembered more information from slides that they photographed. The researchers speculated that this enhancement could be due to the underlying goal of taking the photos. In educational contexts, such as a lecture, the intent behind taking photos is likely to aid future study or exam preparation. This purposeful approach could enhance memory for the material, as the photos serve as a deliberate tool for learning. In contrast, photo-taking in other contexts, like a museum tour, may be more casual or passive, with the primary goal being to capture the experience or to share it with others, rather than to remember specific details. The study by Ditta et al. was conducted online, which could also affect participants' adherence to the procedure.

The ideas that (a) taking photographs may shift attention from one set of characteristics to another and that (b) motivation and interest can operate a degree of metacognitive control over the deployment of those varying attentional strategies raise an important question: Does taking photographs influence meaningful, inferential, categorical knowledge—a hallmark of an educative experience?

The ability to learn categories is a fundamental cognitive skill that allows us to group different objects under a common label, facilitating generalization and the application of knowledge to novel situations and problems. The ability to accurately categorize novel exemplars is crucial, as it indicates that we have not just memorized specific instances but have also developed a mental representation of the categories themselves. In a typical category learning experiment, participants study exemplars of different categories. At test, they are instructed to categorize novel exemplars of those categories. Humans can quickly learn abstract knowledge about how categories are organized, even for categories that they have never seen examples of (Perfors & Tenenbaum, 2009). However, the effect of taking photos during learning of categories is unknown. Rehder and Hoffman (2005a, 2005b) suggested that category learning occurs as a process of selectively attending to category-diagnostic dimensions. The act of taking a photograph may divert attention away from processing diagnostic details and learning categories, which would lead to poorer internal representations of the categories. On the other hand, photo-taking might encourage people to focus on specific visual details they might otherwise overlook, potentially enhancing visual memory and aiding in category learning.

The Present Investigation

The extant work on the photo-taking impairment has focused on examining memory specifically. However, in many everyday and educational contexts, the primary goal is often to learn patterns and infer concepts. *How does taking photos affect inference and generalization to new materials?* We investigated this question in three experiments. Across these experiments, participants were instructed to learn multiple paintings of various artists such that they would ultimately learn to identify the artists from the styles of the paintings. Each artwork was presented with the artist's name, creating a natural category structure with individual artists as categories (cf. Kornell & Bjork, 2008). For half of the artists, participants observed the paintings of these artists (*observe-only* condition). For the other artists, participants photographed their paintings in addition to observing them (*camera* condition). After study, participants were tested both on their ability to categorize paintings to their artists and on recognition for whether the paintings themselves were old (studied) or new (not studied). Given our focus in the current work on inference and category learning, the evaluation of their categorization performance on the new paintings was of critical interest because it is an index of the ability to generalize acquired information about the artists.

Experiment 1

Method

Participants

A sample size of 90 was required to achieve a power of 80% to detect a small effect size ($d = 0.30$) using a two-tailed paired-samples t test. This was the target sample size for this and subsequent experiments reported in this article. Ninety-five undergraduate students from the University of Illinois Urbana-Champaign were recruited in return for course credit. The mean age of participants was 20.22 years, ranging from 19 to 26 ($SD = 1.27$), and 63 of them reported as female. Fifteen participants indicated their ethnicity as Hispanic or Latino. Forty-two participants identified their race as White, eight participants as Black or African American, 35 participants as Asian, and 10 participants as other (participants could choose more than one race category).

Materials

The materials, which were taken from the study by Kornell and Bjork (2008), included landscapes and skyscapes painted by 12 artists: Bruno Pessani, Ciprian Stratulat, George Wexler, Georges Braque, Georges Seurat, Henri-Edmond Cross, Judy Hawkins, Marilyn Mylrea, Philip Juras, Ron Schlorff, Ryan Lewis, and Yie Mei.[1] Many of the artists were contemporary and did not fit into an established style, though there were artists associated with cubism (Georges Braque), impressionism (Henri-Edmond Cross, Georges Seurat), and realism (George Wexler). The stimuli are publicly accessible at https://sites.williams.edu/nk2/stimuli/. There were 10 paintings by each artist, for a total of 120 paintings. All paintings were resized to fit within a 15 × 11 cm rectangle on a computer screen.

Participants were given either a Samsung Galaxy S4 or a Samsung Galaxy S5 smartphone, both of which contained only the default applications and operated in airplane mode throughout the study. Participants were instructed on how to access the camera directly from the lock screen without unlocking the phone to prevent distractions from other features or applications.

Design

There were two within-subject variables: encoding condition (camera vs. observe-only) and study status (old painting vs. new painting).

Each artist was randomly assigned to either the observe-only or camera condition, and all artists had paintings appear during study. For each artist, five paintings were randomly assigned to be studied during the study phase, with the remaining paintings to appear as new paintings at test; hence, at test, all 10 paintings from each artist were assessed.

The camera and observe-only trials were organized in blocks for each artist; participants studied five consecutive paintings by the same artist before moving to the next artist from the other encoding condition. The order of camera and observe-only trials was counterbalanced such that participants with even subject numbers began the experiment with the camera condition, while those with odd subject numbers began with the observe-only condition. Once they studied the five study paintings for all 12 artists, the process was repeated two more times. To maintain a roughly consistent retention interval across conditions, the order of artists was maintained, but the order of the five paintings for each artist was shuffled in each of three blocks to mitigate order effects. Consequently, participants studied each of the five paintings from each artist three times, for a total of 15 s for each painting.

Procedure

Participants were informed that they would be learning to classify paintings from various artists and should learn the painting styles associated with each artist. Each participant was provided with a smartphone and given a demonstration on how to use the camera application on the phone. The experiment was conducted in the lab and consisted of three phases: training, study, and memory test.

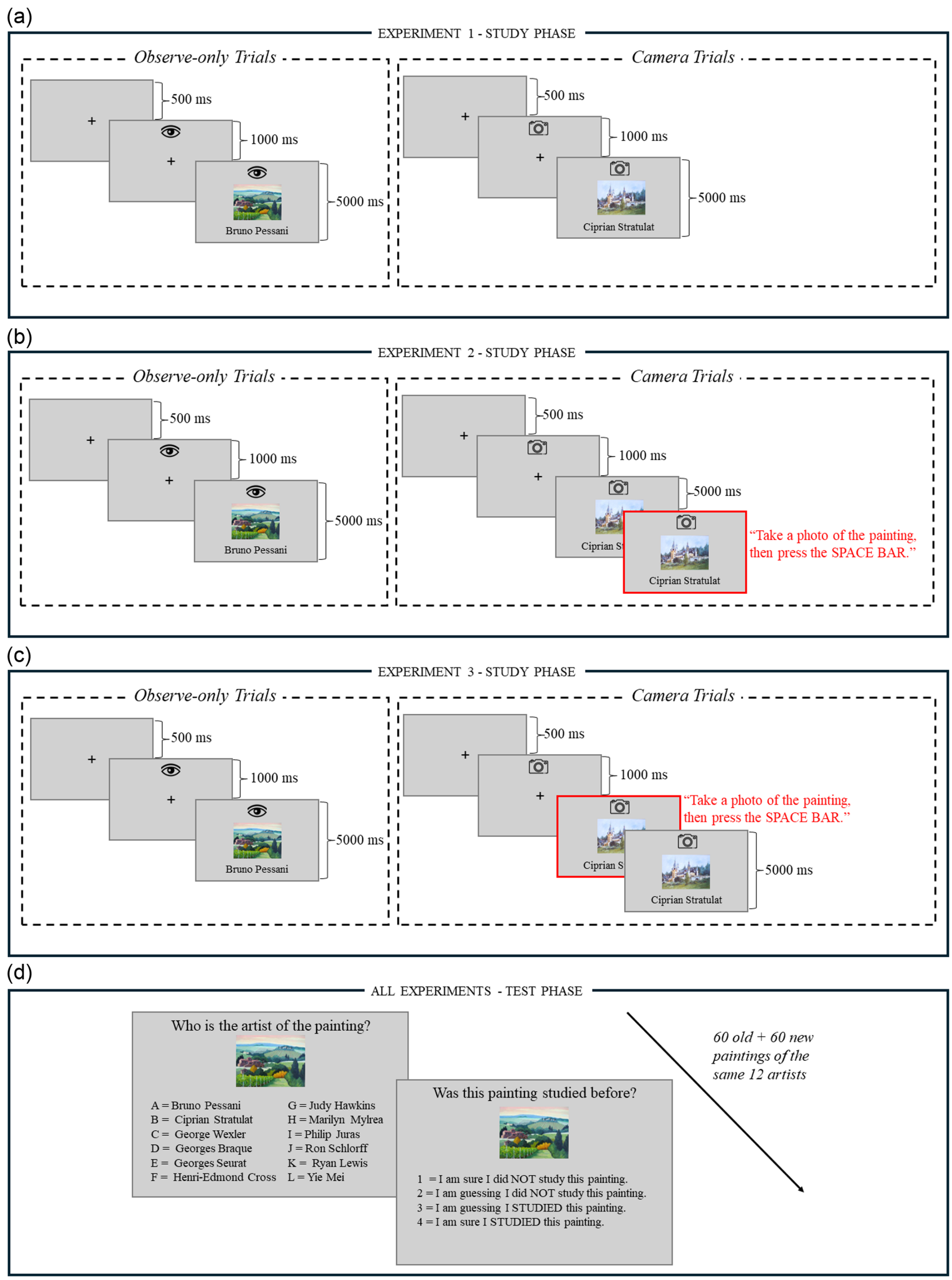
The initial phase involved a brief training session to familiarize participants with the tasks. There were two practice trials for each encoding condition. Portraits, selected from the Web Gallery of Art website (https://www.wga.hu/index.html), were used for these practice trials instead of landscapes or skyscapes to minimize potential interference with the study materials.

Participants then advanced to the study phase. Figure 1a demonstrates an example of the observe-only and camera trials in Experiment 1.

After completing the study phase, participants were instructed to return the phone to the experimenter. Following a 1-min delay,

[1] We asked participants at the end of the experiment if they were familiar with any of the artists presented during the experiment. The number of participants who stated familiarity with at least one artist was very low: 5.3% ($n = 5$) in Experiment 1, 7.4% ($n = 7$) in Experiment 2, and 8.5% ($n = 8$) in Experiment 3.

Figure 1
Example Study and Test Trials for Experiments 1–3



Note. An illustration of how the observe-only and camera trials were presented during the study phase in (a) Experiment 1, (b) Experiment 2, and (c) Experiment 3. (d) The test phase was identical for all three experiments and is illustrated in the last panel. See the online article for the color version of this figure.

during which participants solved two-digit arithmetic problems, they received a test (see Figure 1d). The test included all studied paintings and five new paintings from each artist, for a total of 120 paintings. The order of test trials was pseudorandomized to ensure that no more than three trials of the same encoding condition would appear consecutively. These paintings were displayed one at a time on the screen. For each painting, participants first answered a categorization forced-choice question. They were provided with the names of all 12 artists and asked to choose the correct artist for the respective painting using the keyboard. After determining the artist of the painting, participants were presented with a recognition question for the same painting; they indicated on a scale from 1 to 4 their assessment of whether the painting was one that they had studied earlier, where 1 indicated "I am sure I did NOT study this painting," 2 indicated "I am guessing I did NOT study this painting," 3 indicated "I am guessing I STUDIED this painting," and 4 indicated "I am sure I STUDIED this painting." This response scale remained on the screen while participants provided their response. Upon completing the test, participants were given a debriefing and thanked for their participation. The experimenter checked all the photos taken by the participant to ensure compliance with the instructions.

Results

All data and analysis files for this and the subsequent experiments can be found at https://osf.io/se8j7 (Ünal, 2024). Effect sizes for pairwise comparisons of means are reported as Cohen's *d*, and effect sizes for analyses of variance (ANOVAs) are reported as partial η squared (η_p^2). We used the *rstatix* package in R (Kassambara, 2020) to conduct null hypothesis significance testing.

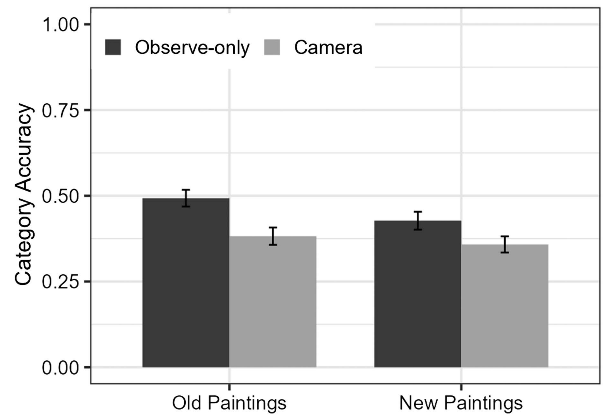
In addition to null hypothesis significance testing methods, we also report Bayes factors (BFs). There are numerous advantages of BFs (see Wagenmakers et al., 2018, for an overview); we include BFs in part for the opportunity to characterize evidence in favor of the null hypothesis (Rouder et al., 2009). We used the *BayesFactor* package in R (Morey et al., 2015) and maintained the default prior suggested in the package (a Cauchy distribution with a scale parameter set to $r = .707$ for *t* tests). All BFs are reported in terms of evidence favoring the alternative hypothesis (BF_{10}). By custom, values of $BF_{10} > 3$ indicate evidence favoring the alternative hypothesis, and values where $BF_{10} < 0.3$ indicate evidence supporting the null hypothesis. Values between those thresholds are considered to be ambiguous. For ease of readability, BFs greater than 100 are reported as $BF_{10} > 100$, and BFs greater than 1,000 are reported as $BF_{10} > 1{,}000$.

Category Learning

Figure 2 shows the mean accuracy in correctly identifying the artists of paintings for old and new paintings. Note that there were 12 artists from whom participants had to identify the artist of the painting, making the chance level of performance in this task ~0.08. A two-way repeated measures ANOVA (Study Status: Old vs. New × Encoding Condition: Observe-Only vs. Camera) showed a main effect of the encoding condition; the observe-only condition resulted in higher category accuracy as compared to the camera condition, $F(1, 94) = 21.82, p < .001$, 95% CI [0.05, 0.13], $\eta_p^2 = .19$, $BF_{10} > 1{,}000$. There was also a main effect of the study status such that participants were better at identifying the artist for previously studied (old) paintings compared to new, unstudied paintings, $F(1, 94) = 41.30, p < .001$, 95% CI [0.03, 0.06], $\eta_p^2 = .31$, $BF_{10} = 19.17$. The interaction was significant as well: The negative impact of using the camera was more pronounced for old paintings compared to new paintings, $F(1, 94) = 8.92$, $p = .004$, $\eta_p^2 = .09$, $BF_{10} > 1{,}000$.

Figure 2

Mean Accuracy of Artist Identification for Old and New Paintings in Experiment 1



Note. Error bars represent the within-subjects standard error of the mean.

Follow-up pairwise *t* tests revealed that the observe-only condition led to more category learning than the camera condition both for old paintings, $t(94) = 5.40$, $p < .001$, 95% CI [0.07, 0.15], $d = 0.55$, $BF_{10} > 1{,}000$, and new paintings, $t(94) = 3.39$, $p = .001$, 95% CI [0.03, 0.11], $d = 0.35$, $BF_{10} = 22.08$.

Recognition

Confidence ratings were used to generate a measure of discrimination (d_a) between old and new items based on unequal-variance signal-detection theory[2] (Green & Swets, 1966; for a discussion of the advantages of d_a measure in recognition, see Matzen & Benjamin, 2009). Three participants were excluded from the discriminability analysis because they placed all their responses at a single level of confidence; d_a values for these participants could not be computed. Hit and false alarm (FA) rates[3] for each condition and mean discriminability (d_a) values are shown in Figure 3.

The observe-only condition resulted in greater discriminability than the camera condition, $t(91) = 2.17$, $p = .03$, 95% CI [0.01, 0.29], $d = 0.23$. However, evidence from BFs was ambiguous ($BF_{10} = 1.08$), and so this result must be considered provisional.

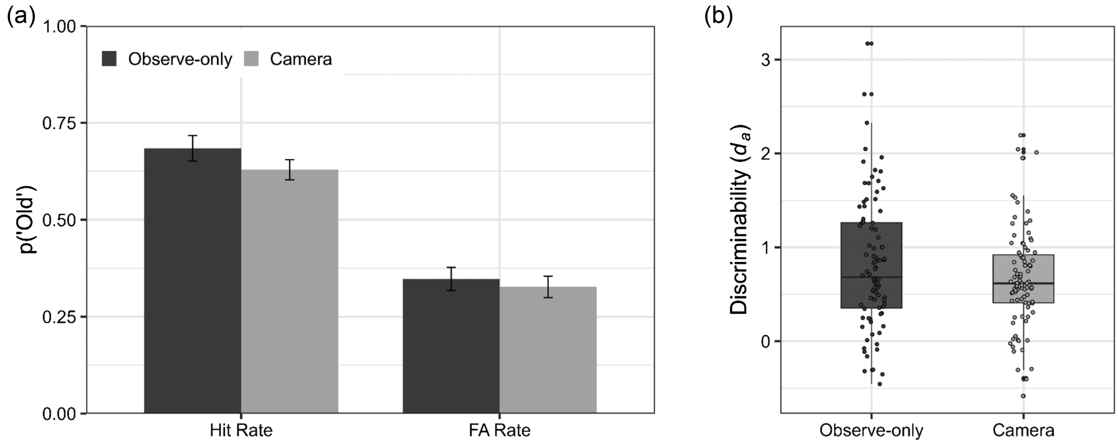
Discussion

The results of Experiment 1 demonstrated that photographing impaired category learning. Participants were more accurate in identifying the artist of a painting when the artists' paintings were

[2] Readers interested in the related measure, d', can refer to the analysis files.

[3] Hit and FA rates that were equal to 0 were corrected by replacing them with $1/2n$, where *n* refers to the number of old or new items, respectively; and scores of 1 were replaced by $1 - (1/2n$; Macmillan & Kaplan, 1985).

Figure 3
Hit and False Alarm Rates, and Discriminability Results in Experiment 1



Note. (a) Mean probability of identifying a painting as "old" as a function of encoding condition in Experiment 1. Hit Rate refers to the probability of correctly identifying a studied painting as old, and FA (false alarm) Rate refers to the probability of identifying an unstudied painting as old. Error bars represent the within-subjects standard error of the mean. (b) Discriminability (d_a) values as a function of the encoding condition in Experiment 1.

solely observed and not photographed. This was true for entirely new paintings as well as the studied paintings. Participants were also better at recognizing whether a painting was studied when it was observed only during the study phase, compared to when it was photographed.

A key aspect in both the current investigation and relevant earlier work is study duration. Given that photographing takes time, our results might reflect a divided-attention cost of taking the photograph. Henkel (2014) and Soares and Storm (2018) addressed this confound by equating observation time across observe-only and camera conditions (or allocating even greater time in the camera condition). We address this in Experiment 2 similarly, by providing additional study time for the camera condition. This serves as a conservative test of the photo-taking impairment and should rule out reduced study time for the camera condition as an explanation for the impairment.

Experiment 2

In Experiment 2, in the camera trials, participants were asked to first observe the painting for 5 s, and only after that interval were they instructed to photograph the painting. That is, participants could observe the painting without disruption for 5 s on each trial regardless of condition.

Method

Participants

Ninety-five undergraduate students from the University of Illinois Urbana-Champaign participated in this experiment in return for course credit. The mean age of participants was 19.18 years, ranging from 18 to 25 (SD = 1.20), and 62 reported as female. Sixteen participants indicated their ethnicity as Hispanic or Latino. Fifty-two participants identified their race as White, 29 participants as Asian, nine participants as Black or African American, two participants as Native Hawaiian or other Pacific Islander, three participants as American Indian or Alaska Native, and two participants as other (participants could choose more than one race category).

Materials, Design, and Procedure

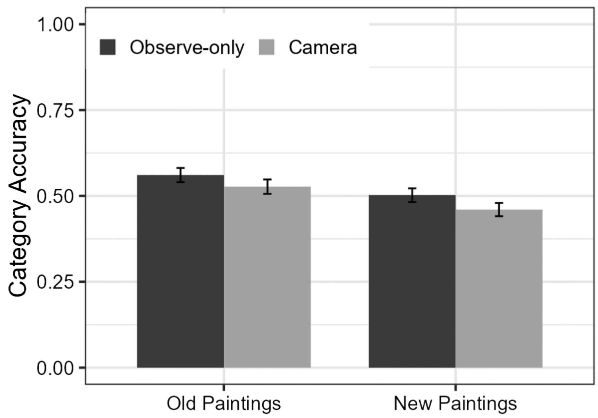
The same materials were used as in Experiment 1. The design and procedure closely matched those of Experiment 1, with the exception of the camera trials. On these trials, participants were first presented with the camera icon at the top of the screen for 1 s. The camera icon remained on the screen as the painting was subsequently displayed in the center, along with the artist's name underneath it. Participants were instructed to observe the painting for an uninterrupted 5 s. Subsequently, an instruction appeared beneath the camera icon and at the top of the painting, prompting participants to "Take a photo of the painting, then press the SPACEBAR." Pressing the space bar initiated the next trial. Participants took as much time as they needed to photograph the painting. Like in Experiment 1, training trials were provided at the beginning to familiarize participants with the task. The mean of participants' median photographing times during the study phase was 3.71 s. Figure 1b shows the study phase of Experiment 2. All other aspects of the experiment were the same as Experiment 1.

Results

Category Learning

Figure 4 presents the mean category accuracy for artist identification for old and new paintings. A two-way repeated measures ANOVA revealed a significant main effect of encoding condition: Artists that were in the observe-only condition were learned better than the artists that were in the camera condition, $F(1, 94) = 6.84$, $p = .01$, 95% CI [0.01, 0.07], $\eta_p^2 = .07$, $BF_{10} = 34.81$. Category accuracy was also higher for old paintings than for new paintings, $F(1, 94) = 77.68$, $p < .001$, 95% CI [0.05, 0.08], $\eta_p^2 = .45$, $BF_{10} >$ 1,000. The interaction was not significant, $F(1, 94) = 0.30$, $p = .58$, $\eta_p^2 = .003$, $BF_{10} = 0.16$. Follow-up pairwise t tests revealed that, for

Figure 4
Mean Accuracy of Artist Identification for Old and New Paintings in Experiment 2



Note. Error bars represent the within-subjects standard error of the mean.

new paintings, the observe-only condition led to superior category learning compared to the camera condition, $t(94) = 2.67$, $p = .01$, 95% CI [0.01, 0.07], $d = 0.27$, $BF_{10} = 3.21$. For old paintings, a traditional null hypothesis test revealed a significant advantage of the observe-only condition over the camera condition, $t(94) = 2.02$, $p = .046$, 95% CI [0.001, 0.07], $d = 0.21$; however, evidence from BFs was ambiguous, $BF_{10} = 0.79$.

Recognition

Figure 5 presents the hit and FA rates for each condition, collapsing responses from all levels of confidence, and mean discriminability (d_a) values. One participant was excluded from this analysis because they provided only one level of confidence for all their responses. There was no difference between the observe-only and camera conditions, $t(93) = 1.02$, $p = .31$, 95% CI [−0.09, 0.27], $d = 0.11$, $BF_{10} = 0.19$, in discriminability.

Discussion

Experiment 2 replicated the photo-impairment effect on inference observed in Experiment 1: Participants exhibited better artist identification accuracy for unstudied paintings when they had solely observed (and not photographed) the artist's paintings during encoding. Critically, this occurred even though the camera condition included more total exposure time to the learning materials.

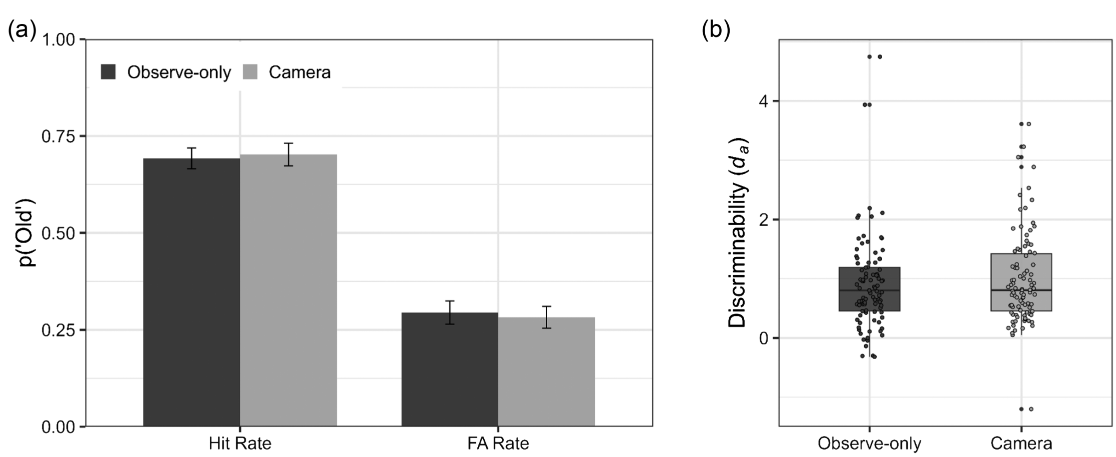
Recognition memory was roughly the same for artists whose paintings were solely observed and those whose paintings were additionally photographed. We return to this finding in the Combined Results and General Discussion sections.

Control over study duration has been a key aspect of extant work on the photo-taking impairment, under the theory that taking a photograph itself interferes with observing and encoding the stimulus. Although we found a continued impairment of inference even when exposure time was controlled in Experiment 2, it is worth considering interference effects beyond the physical act of taking a photograph. Specifically, the order in which someone takes a photo and observes the object may affect attention to the object. When participants photograph the paintings at the end of the trial, as in Experiment 2, the preparation to photograph the painting may have itself diverted attention from the painting itself, disrupting key encoding processes. Similar effects are evident in other cases in which planning is required, such as sentence production (Boiteau et al., 2014). We address this in Experiment 3 by reversing the order of observation and photographing time in the camera condition.

Experiment 3

In Experiment 3, in the camera trials, participants were instructed to photograph the painting *first* and then press a key to start their 5 s

Figure 5
Hit and False Alarm Rates, and Discriminability Results in Experiment 2



Note. (a) Mean probability of identifying a painting as "old" as a function of encoding condition in Experiment 2. Hit Rate refers to the probability of correctly identifying a studied painting as old, and FA (false alarm) Rate refers to the probability of identifying an unstudied painting as old. Error bars represent the within-subjects standard error of the mean. (b) Discriminability (d_a) values as a function of the encoding condition in Experiment 2.

of viewing time. Photographing the paintings first should mitigate any concerns about preparing to photograph disrupting learning.

Method

Participants

Ninety-four undergraduate students from the University of Illinois Urbana-Champaign participated in this experiment in return for course credit. The mean age of participants was 19.02 years, ranging from 18 to 24 (SD = 1.03), and 69 participants reported as female. Nineteen participants indicated their ethnicity as Hispanic or Latino. Forty-five participants identified their race as White, 43 participants as Asian, five participants as Black or African American, one participant as Native Hawaiian or other Pacific Islander, and six participants as other (participants could choose more than one race category).

Materials, Design, and Procedure

The same materials were used as in Experiments 1 and 2. The design and procedure closely matched those of Experiment 2, with the only difference occurring in the camera trials. On these trials, prior to observing, the camera icon first appeared at the top of the screen for 1 s, followed by the painting appearing at the center and the artist's name underneath it. Simultaneously, participants were prompted with an instruction upon encountering the painting, directing them to "Take a photo of the painting, then press the SPACEBAR" located beneath the camera icon and on top of the painting. The mean of participants' median photographing times was 3.95 s. After photographing the painting using the smartphone, pressing the space bar removed this instruction from the screen and initiated their 5 s period to study the painting while the camera icon, painting, and the artist's name remained on the screen (see Figure 1c). As in previous experiments, participants completed training trials to familiarize themselves with the task. All other aspects of the experiment were also the same as Experiment 2.

Results

Category Learning

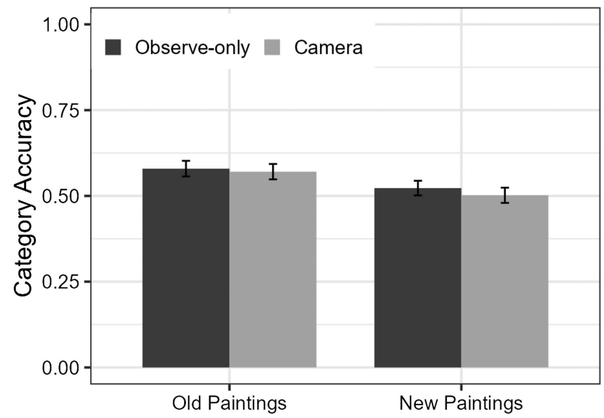
Figure 6 presents the mean category accuracy for artist identification for old and new paintings. A two-way repeated measures ANOVA revealed that the main effect of the encoding condition was not statistically significant, and in fact evidence favored the null hypothesis of no difference, $F(1, 93) = 0.77$, $p = .38$, 95% CI [−0.04, 0.02], $\eta_p^2 = .01$, $BF_{10} = 0.25$. There was a main effect of study status, such that categorization was better for old paintings than for new paintings, $F(1, 93) = 81.20$, $p < .001$, 95% CI [0.05, 0.08], $\eta_p^2 = .47$, $BF_{10} > 1{,}000$. The interaction was not significant, $F(1, 93) = 0.98$, $p = .32$, $\eta_p^2 = .01$, $BF_{10} = 0.19$.

Recognition

Figure 7 presents the hit and FA rates for each condition, collapsing responses from all levels of confidence, and mean discriminability (d_a) values. Three participants were excluded from this analysis because they only used a single level of confidence for all their responses. For the remaining 91 participants, there was no difference between the mean d_a values of the observe-only and

Figure 6

Mean Accuracy of Artist Identification for Old and New Paintings in Experiment 3



Note. Error bars represent the within-subjects standard error of the mean.

camera conditions, $t(90) = 0.02$, $p = .99$, 95% CI [−0.15, 0.15], $d = 0.01$, $BF_{10} = 0.12$.

Discussion

In contrast to prior findings, the results of Experiment 3 suggest that photographing a painting prior to observing it does not significantly impact the learning of artists compared to solely observing the paintings without capturing their photos. Accuracy in recognizing whether a painting was studied was also the same, regardless of whether they solely observed the painting or first took a photograph before observation.

Combined Results

All Experiments

To evaluate the effect of taking a photograph with higher power, the combined data from all experiments were analyzed.

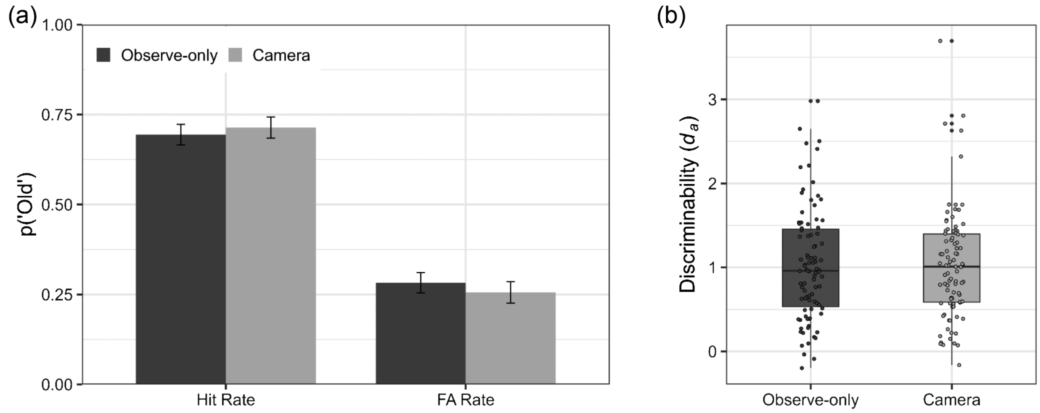
Category Learning

The main effect of the encoding condition was significant; the observe-only condition yielded superior learning of the artists compared to the camera condition, $F(1, 283) = 22.90$, $p < .001$, 95% CI [0.03, 0.07], $\eta_p^2 = .08$, $BF_{10} > 1{,}000$. The main effect of study status was also significant; categorization was higher for studied paintings than for new paintings, $F(1, 283) = 194.43$, $p < .001$, 95% CI [0.05, 0.07], $\eta_p^2 = .41$, $BF_{10} > 1{,}000$. The interaction was not significant, $F(1, 283) = 0.81$, $p = .37$, $\eta_p^2 = .003$, $BF_{10} = 0.11$. Follow-up tests showed that the observe-only condition led to higher category accuracy for both studied paintings, $t(284) = 4.66$, $p < .001$, 95% CI [0.02, 0.07], $d = 0.28$, $BF_{10} > 1{,}000$, and for new paintings, $t(284) = 4.22$, $p < .001$, 95% CI [0.02, 0.06], $d = 0.25$, $BF_{10} > 100$.

Recognition

For recognition memory, the difference between the mean d_a values of the observe-only and camera conditions was not statistically

Figure 7
Hit and False Alarm Rates, and Discriminability Results in Experiment 3



Note. (a) Mean probability of identifying a painting as "old" as a function of encoding condition in Experiment 3. Hit Rate refers to the probability of correctly identifying a studied painting as old, and FA (false alarm) Rate refers to the probability of identifying an unstudied painting as old. Error bars represent the within-subjects standard error of the mean. (b) Discriminability (d_a) values as a function of the encoding condition in Experiment 3.

significant, $t(276) = 0.44$, $p = .67$, 95% CI [−0.11, 0.07], $d = 0.02$. Evidence from the BF also provided evidence for this lack of difference ($BF_{10} = 0.07$). This finding, though not central to the focus of this article, is surprising, since it contrasts with prior research. We additionally examined condition effects on hit rates in the combined data, since this is a more commonly used measure than d_a in this field (Henkel, 2014). Even in that case, there was no significant difference between the observe-only and camera conditions, $t(276) = 0.74$, $p = .46$, 95% CI [−0.02, 0.01], $d = 0.05$, $BF_{10} = 0.09$. We return to this finding in the General Discussion section.

Experiments 2 and 3

In addition to analyzing data from all three experiments combined, we also conducted a separate analysis of the combined data from Experiments 2 and 3. This analysis provides a more rigorous test of the hypothesis that the decrement to categorization for photographed items perseveres in experiments that include separate intervals for study and taking a photograph.

Category Learning

There was still a main effect of the encoding condition, $F(1, 188) = 5.61$, $p = .019$, 95% CI [0.01, 0.05], $\eta_p^2 = .03$, $BF_{10} = 18.22$, indicating that participants were more accurate at identifying the artist when they had only observed the paintings during the study phase, compared to when they had also photographed them. Additionally, there was a significant main effect of study status such that participants were better at identifying artists of old paintings than new paintings, $F(1, 188) = 159.62$, $p < .001$, 95% CI [0.05, 0.07], $\eta_p^2 = .46$, $BF_{10} = 3.56$. The interaction between the encoding condition and study status was not significant ($p = .29$, $\eta_p^2 = .01$, $BF_{10} = 0.13$). When experiment was added as a between-subject factor, the interaction between experiment and the encoding condition was not significant, $F(1, 187) = 1.05$, $p = .31$, $\eta_p^2 = .01$, though the BF revealed weak evidence for the alternate hypothesis, $BF_{10} = 2.07$.

Follow-up *t* tests revealed that observing the paintings (rather than photographing) led to higher category accuracy for new paintings, $t(188) = 2.67$, $p = .008$, 95% CI [0.01, 0.06], $d = 0.20$, $BF_{10} = 2.53$. For old paintings, this difference was not statistically significant, $t(188) = 1.72$, $p = .088$, 95% CI [−0.05, 0.003], $d = 0.19$, $BF_{10} = 0.34$. This finding further supports that taking photos does impair category learning such that participants were less accurate at identifying the unstudied paintings of artists whose works were photographed during the study phase, even though they had more time to study these artists.

Recognition

As for recognition memory, the difference between the mean d_a values of the observe-only and camera conditions was not statistically significant, $t(184) = 0.77$, $p = .44$, 95% CI [−0.07, 0.16], $d = 0.06$, $BF_{10} = 0.11$.

General Discussion

In the current investigation, we examined the effect of taking photos on category learning. Previous work has shown a memory impairment for photographed objects as compared to observed objects (e.g., Henkel, 2014; Soares & Storm, 2018, 2022). We evaluated whether the photo-taking impairment extended to inference in a category learning task. In Experiment 1, participants were better at identifying the correct artist if they had previously studied the artist by only observing their paintings as compared to when they observed and photographed their paintings. Photographing objects can interfere with the development of representations that underlie inference.

In Experiments 2 and 3, we gave participants additional time to photograph the painting, equating observation time between camera and observe-only conditions (even likely favoring the camera condition). In Experiment 2, participants observed the painting first, then photographed. Here, the photo-taking impairment on inference persisted; participants learned the artists' painting styles better when the paintings were solely observed during encoding, in contrast to when they were also photographed. In Experiment 3, participants photographed and then observed the paintings in the camera condition. Here, we found no significant difference across conditions in the accuracy of identifying the artist of a painting between photographed and observed-only paintings.

We make any direct comparison of these results across experiments with caution, as these were separate experiments with different participants. Our design does not permit us to determine whether the order of photographing and observing plays a causal role in the observed pattern. Moreover, when analyzing the combined data from Experiments 2 and 3, we found no conclusive effect of the order of photographing and observing. In Experiment 2, when participants viewed the painting first and then photographed it, they were aware of the need to photograph the painting at the end of the trial, a mental burden that may be disruptive to encoding. In contrast, in Experiment 3, when participants photographed the painting first, the subsequent viewing time allowed participants to fully engage in natural, unimpeded encoding processes, at least until the next painting trial. Reducing the attentional resources available for information by distraction from a secondary task is known to impair encoding processes (Craik et al., 1996). The act of taking a photo after observing an object may divert attention away from encoding the object itself and instead focus attention on the preparation of capturing the photograph. This proposed attention-based mechanism draws indirect support from work demonstrating the role of selective attention in category learning (e.g., Rehder & Hoffman, 2005a, 2005b). Future research could explore this by manipulating the order of photographing and observing objects within a single experiment to directly examine the effects of sequencing on learning.

Our results are consistent with current proposed explanations of the photo-taking impairment effect, which suggest that taking photos leads individuals to offload memory (Henkel, 2014) and/or become attentionally disengaged from the object or scene they are capturing (Soares & Storm, 2018). In the present set of experiments, participants were not explicitly informed ahead of time that they would not have access to the camera or photos at test. This could have encouraged an assumption that they would have access to the photos later, potentially reducing the effort they invested in encoding the information. Additionally, it is possible that the act of photo-taking itself diverted attention from the task of deeply processing the paintings, further diminishing their ability to form internal representations. Both mechanisms—cognitive offloading and attentional disengagement—may occur simultaneously, reinforcing the impairing effects of photo-taking on memory.

In contrast to previous research findings, we did not replicate a photo-taking impairment on recognition memory. We do not have a convincing theoretical explanation for this result but do note some important differences between our work and previous work that might play a role. To begin, to our knowledge, no prior study in this limited literature has reported a discriminability index derived from unequal-variance signal-detection theory as an index of recognition performance. Within the literature on recognition memory, d_a and related measures are widely recognized as superior measures to common alternatives (e.g., Swets, 1986). Another difference between our approach and other work examining the photo-taking impairment effect on memory includes our use of a recognition memory test (12-alternative-forced-choice for the 12 artists). This differs from a standard old/new recognition test format and was necessary to examine our key interest in inference and category learning. A final difference in our work compared to previous work is that, here, participants were asked to categorize the painting to the proper artist prior to responding to the recognition memory test trial. This order in responding may have influenced participants' responses to the recognition memory questions. While this design choice allowed us to address our primary question about category learning without interference, it may have affected the recognition measure of the photo-taking impairment. It is possible that these differences in statistical approach, measures, and procedure led to the unexpected null outcome on the memory measure.

Our findings suggest that taking photos can hinder learning and the generalization of knowledge, but more work is needed to understand such effects in naturalistic experience. Taking photos of materials presented via computer screen is unlikely to represent the majority of contexts wherein individuals wish to take photographs. Moreover, in contrast to taking photos in a controlled laboratory environment, we have the freedom in our lives to revisit photos at our convenience. Those review processes might support conceptual learning that is lost during the act of taking the photograph. But the ubiquity of smartphone cameras has led to a surge in the quantity of photos taken, and people report feeling overwhelmed by the sheer volume of accumulated photos, leading to less frequent reviews of photos than intended (Ceroni, 2018). If reviewing photos becomes more burdensome than beneficial, we may need to reconsider the value of taking photos in the context of learning.

It is also worth noting that in the present study, participants were instructed on which items to photograph and which ones to simply observe. This approach provides precise experimental control but is unlikely to represent the majority of "real-life" photo-taking scenarios. When deciding what to photograph, individuals likely search for aspects of an experience that they desire to capture.

Taking photos appears to impair the generalization of learning beyond the specific materials under study. These findings indicate a need for careful consideration for when individuals are encouraged to use their smartphone cameras, with implications not only within the classroom but also in broader learning contexts.

References

Barasch, A., Diehl, K., Silverman, J., & Zauberman, G. (2017). Photographic memory: The effects of volitional photo taking on memory for visual and auditory aspects of an experience. *Psychological Science*, *28*(8), 1056–1066. https://doi.org/10.1177/0956797617694868

Benjamin, A. S. (2007). Memory is more than just remembering: Strategic control of encoding, accessing memory, and making decisions. *Psychology of Learning and Motivation*, *48*, 175–223. https://doi.org/10.1016/S0079-7421(07)48005-7

Boiteau, T. W., Malone, P. S., Peters, S. A., & Almor, A. (2014). Interference between conversation and a concurrent visuomotor task. *Journal of Experimental Psychology: General*, *143*(1), 295–311. https://doi.org/10.1037/a0031858

Ceroni, A. (2018). Personal photo management and preservation. In V. Mezaris, C. Niederée, & R. H. Logie (Eds.), In *Personal multimedia preservation: Remembering or forgetting images and video* (pp. 279–314). Springer.

Craik, F. I. M., Govoni, R., Naveh-Benjamin, M., & Anderson, N. D. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General*, *125*(2), 159–180. https://doi.org/10.1037/0096-3445.125.2.159

Ditta, A. S., Soares, J. S., & Storm, B. C. (2023). What happens to memory for lecture content when students take photos of the lecture slides? *Journal of Applied Research in Memory and Cognition*, *12*(3), 421–430. https://doi.org/10.1037/mac0000069

Dupre, C., Peper, P., & Ball, B. H. (2024). The role of offloading intentions on future-oriented thinking. *Psychonomic Bulletin & Review*, *31*(3), 1387–1397. https://doi.org/10.3758/s13423-023-02423-x

Fiechter, J. L., Benjamin, A. S., & Unsworth, N. (2016). The metacognitive foundations of effective remembering. In J. Dunlosky & S. K. Tauber (Eds.), *The Oxford handbook of metamemory* (pp. 307–324). Oxford University Press.

Green, D. M., & Swets, J. A. (1966). *Signal detection theory and psychophysics* (Vol. 1). Wiley.

Hamilton, K. A., & Benjamin, A. S. (2019). The human-machine extended organism: New roles and responsibilities of human cognition in a digital ecology. *Journal of Applied Research in Memory and Cognition*, *8*(1), 40–45. https://doi.org/10.1016/j.jarmac.2019.01.001

Henkel, L. A. (2014). Point-and-shoot memories: The influence of taking photos on memory for a museum tour. *Psychological Science*, *25*(2), 396–402. https://doi.org/10.1177/0956797613504438

Kassambara, A. (2020) *rstatix: Pipe-Friendly Framework for Basic Statistical Tests* (Version 0.7.2) [R package]. https://cran.r-project.org/web/packages/rstatix/index.html

Kelly, M. O., & Risko, E. F. (2022). Study effort and the memory cost of external store availability. *Cognition*, *228*, Article 105228. https://doi.org/10.1016/j.cognition.2022.105228

Kornell, N., & Bjork, R. A. (2008). Learning concepts and categories: Is spacing the “enemy of induction”? *Psychological Science*, *19*(6), 585–592. https://doi.org/10.1111/j.1467-9280.2008.02127.x

Lurie, R., & Westerman, D. L. (2021). Photo-taking impairs memory on perceptual and conceptual memory tests. *Journal of Applied Research in Memory and Cognition*, *10*(2), 289–297. https://doi.org/10.1016/j.jarmac.2020.11.002

Macmillan, N. A., & Kaplan, H. L. (1985). Detection theory analysis of group data: Estimating sensitivity from average hit and false-alarm rates. *Psychological Bulletin*, *98*(1), 185–199. https://doi.org/10.1037/0033-2909.98.1.185

Matzen, L. E., & Benjamin, A. S. (2009). Remembering words not presented in sentences: How study context changes patterns of false memories. *Memory & Cognition*, *37*(1), 52–64. https://doi.org/10.3758/MC.37.1.52

Morey, R. D., Rouder, J. N., Jamil, T., & Morey, M. R. D. (2015). *Package ‘bayesfactor’*. https://cran.r-project.org/web/packages/BayesFactor/index.html

Perfors, A., & Tenenbaum, J. (2009). Learning to learn categories. *Proceedings of the annual meeting of the Cognitive Science Society* (Vol. *31*, No. 31). Cognitive Science Society.

Pew Research Center. (2024). *Mobile fact sheet*. https://www.pewresearch.org/internet/fact-sheet/mobile/

Rehder, B., & Hoffman, A. B. (2005a). Thirty-something categorization results explained: Selective attention, eyetracking, and models of category learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *31*(5), 811–829. https://doi.org/10.1037/0278-7393.31.5.811

Rehder, B., & Hoffman, A. B. (2005b). Eyetracking and selective attention in category learning. *Cognitive Psychology*, *51*(1), 1–41. https://doi.org/10.1016/j.cogpsych.2004.11.001

Risko, E. F., & Gilbert, S. J. (2016). Cognitive offloading. *Trends in Cognitive Sciences*, *20*(9), 676–688. https://doi.org/10.1016/j.tics.2016.07.002

Rouder, J. N., Speckman, P. L., Sun, D., Morey, R. D., & Iverson, G. (2009). Bayesian *t* tests for accepting and rejecting the null hypothesis. *Psychonomic Bulletin & Review*, *16*(2), 225–237. https://doi.org/10.3758/PBR.16.2.225

Soares, J. S., & Storm, B. C. (2018). Forget in a flash: A further investigation of the photo-taking-impairment effect. *Journal of Applied Research in Memory and Cognition*, *7*(1), 154–160. https://doi.org/10.1016/j.jarmac.2017.10.004

Soares, J. S., & Storm, B. C. (2022). Does taking multiple photos lead to a photo-taking-impairment effect? *Psychonomic Bulletin & Review*, *29*(6), 2211–2218. https://doi.org/10.3758/s13423-022-02149-2

Swets, J. A. (1986). Indices of discrimination or diagnostic accuracy: Their ROCs and implied models. *Psychological Bulletin*, *99*(1), 100–117. https://doi.org/10.1037/0033-2909.99.1.100

Ünal, B. (2024, September 23). *The disruptive effect of taking photos on learning abstract categories*. https://osf.io/se8j7

Wagenmakers, E. J., Marsman, M., Jamil, T., Ly, A., Verhagen, J., Love, J., Selker, R., Gronau, Q. F., Šmíra, M., Epskamp, S., Matzke, D., Rouder, J. N., & Morey, R. D. (2018). Bayesian inference for psychology. Part I: Theoretical advantages and practical ramifications. *Psychonomic Bulletin & Review*, *25*(1), 35–57. https://doi.org/10.3758/s13423-017-1343-3

Received May 22, 2024
Revision received March 29, 2025
Accepted April 16, 2025 ■