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Aesthetic experience is supported by spontaneous autobiographical memory recollection

Anna P. Smith[1] · **Felipe De Brigard**[1] · **Elizabeth J. Marsh**[1]

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Abstract
What mental representations and processes support moving aesthetic reactions to abstract art? We argue that the elicitation of autobiographical memories enables viewers to appreciate abstract art through the process of personal meaning-making. In three studies, we gave participants the opportunity to associate personal memories with works of art and measured how aesthetically moved they felt while viewing. We found that participants were significantly more moved by paintings that they could associate with a specific episode in their life (Study 1). This effect replicated across all studies and was present, albeit slightly weaker, even when the memory was cued after aesthetic ratings was made (Study 2). However, the positive effect of memory association on aesthetic experience diminished significantly when participants were asked to associate memories with all paintings (Study 3). These findings suggest that memory recollection enhances aesthetic experience when it arises spontaneously during art viewing.

Keywords Autobiographical memory · Aesthetic experience · Self-relevance

Introduction

Yellow, by sculptor Sir Anish Kapoor, is a 20-foot piece of square fiberglass painted in vibrant monochrome with a soft radial gradient at its center. For the first author, viewing this painting cued a memory of a family walk through a sunflower field; for the third author, this painting cued a memory of crafting using yellow beads; another lab member reading the paper did not spontaneously retrieve a memory upon viewing its image. Here, we explore the role such recollections play in people's responses to artwork, building on the growing literature in cognitive psychology and neuroscience that explores the roles of bottom-up (e.g., perceptual features) and top-down processes (e.g., meaning-making) in people's aesthetic responses. To preview, we argue that autobiographical memory and aesthetic experience mutually facilitate one another, adding to the growing literature on the role of explicit memory recollection in aesthetic experience.

✉ Anna P. Smith
anna.p.smith@duke.edu

[1] Department of Psychology and Neuroscience, Duke University, 417 Chapel Drive, Durham, NC 27708, USA

What is an aesthetic experience?

Aesthetic experience can be described as a composite mental state of perceptual, emotional, and semantic processing that unfolds while engaging with art (Chatterjee & Vartanian, 2014; Pelowski et al., 2017). The field of empirical aesthetics, correspondingly, is a patchwork of complementary definitions and approaches to studying such experiences. For instance, a vision researcher may only be interested in which images participants prefer, while a researcher studying the cognitive contributions to aesthetic experience might ask study participants how meaningful or interesting they find a work of art.

Although major theoretical frameworks in empirical aesthetics account for a range of motivational, emotional, and cognitive outcomes of arts engagement, aesthetic experience is most frequently operationalized experimentally as either "aesthetic liking" or "the feeling of being aesthetically moved" (Dokic, 2016). In the aesthetic domain, "liking" denotes a basic positive affective or motivational orientation toward a work of art, considered by some to be precognitive or automatic (Berlyne, 1973; Zajonc, 1984).

Although the feeling of being "moved" by art might precipitate or coincide with a feeling of liking, psycholinguistic modeling work on common aesthetic experience

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terms (collected in the Aesthetic Emotions Scale, or AESTHEMOS) demonstrates that the feeling of being "moved" does not predictably coincide with any single affective state and thus cannot be detected on the basis of affective valence alone (Schindler et al., 2017). This state is instead distinguished by a presence of mnemonic or self-relevant thought content (Menninghaus et al., 2015) and is situated in semantic space beside similar AESTHEMOS items related to learning and memory, such as nostalgia, fascination, and awe (Beermann et al., 2021). These states are collectively associated with a desire to "seek continued and repeated exposure" to the situations that elicit them (Beermann et al., 2021) and are described as "enjoyable variants of basically negative or mixed emotional states" (Schindler et al., 2017). Besides aesthetic liking and moving, the AESTHEMOS includes 75 word labels, collected from relevant psychometric questionnaires and field studies, that have been dimensionally reduced into seven factors: negative emotions (i.e., bored, confused), prototypical aesthetic emotions (i.e., moved, fascinated), epistemic emotions (i.e., challenged, curious), animation (i.e., energized, enchanted), nostalgia/relaxation, sadness, and amusement (Schindler et al., 2017). The range of valid instantiations of aesthetic experience represented in this instrument is highlighted to reinforce the appropriateness of complementary perceptual, affective, and cognitive approaches to empirical aesthetics research.

Featural determinants of aesthetic experience

Machine learning models trained to detect basic and high-level image features can now be applied to determine the extent to which aesthetic experience (in this case, aesthetic liking) are consistently predictable as opposed to idiosyncratic. Iigaya et al. (2021) found that a single computer vision parameter, *concreteness*, predicted a full 40% of the variability of 1,359 participants' aesthetic ratings of paintings and photographs. However, 78% of their participants formed a majority cluster of highly predictable rating behavior, preferring landscape paintings and images of human faces.

On one hand, the predictiveness of the *concreteness* parameter, which corresponds to high contrast and predictable underlying image structure, accords with an evolutionary explanation of aesthetic experience. Ramachandran and Hirstein (1999), for example, suggested in their "eight laws of artistic experience" that aesthetic experience co-opts visual system pathways tuned to detect camouflage and survival value indicators in the environment. Some features purported to "please" our visual systems are likewise linked to the ease of processing visual complexity: symmetry, exaggeration of proportions, presence of grouping principles, and correlation of features in a scene (Reber et al., 2004). An alternative nonfeatural explanation, however, is that *concreteness* simply describes a subset of images that are universally and readily interpretable, reflecting a preference for unambiguous forms. In a similar study by Chen et al. (2022), participants rating images of recognizable (i.e., concrete) everyday objects again formed a majority cluster of predictable aesthetic rating behavior. However, because these images visually resembled one another, these participants could only be identified retroactively by their similarly high "taste typicality" scores, or their latent agreement with the group. Together, these studies may suggest that shared aesthetic preference is highest for realistic images versus abstract, but that the underlying sources of aesthetic conformism cannot always be traced to image features when stimulus interpretability is held constant. Furthermore, understanding the bases for individualized preferences that fall outside of the norm, including experiences of abstract art, remains relegated to other disciplines of cognitive psychology.

Top-down contributions to aesthetic experience

The possibility that aesthetic experience is tied to the interpretability of art may explain why abstract art is rated more idiosyncratically than representational art at the group level (Vessel & Rubin, 2010; Vessel et al., 2013). Landau et al. (2006) speculate that abstract art that does not meet a "minimal condition of meaningfulness" cannot invite or sustain engagement. In the absence of interpretable features, abstract art may engender subjective interpretations that draw in outside sources of information.

From where do individuals source their outside information to interpret abstract art? This question has been approached in relation to implicit memory processes and, to a lesser extent, explicit processes. A proliferation of research surrounds the mere-exposure effect, a phenomenon in which the "mere" repetition of a stimulus leads to a more favorable evaluation of that stimulus (Zajonc, 1968). Although mere exposure has been applied as an explanation for advertisement efficacy, the perpetuation of the artistic canon, and as an overarching mechanism of aesthetic appreciation more broadly, evidence for the effect of previous exposures on painting preference remains elusive (Bornstein et al., 1989; Montoya et al., 2017). As such, the absence of a mere-exposure effect on art preference may be due to explicit, rather than implicit, cognitive processes that override this fluency signal.

Formal knowledge about a given painting may contribute to its appreciation to some extent: titles have been shown to increase aesthetic appreciation in representational art, but only when they encourage a deeper mode of processing than participants would otherwise have time or interest to engage (Millis, 2001; Leder et al., 2006). However, studies comparing art expert and novice's reactions suggests

that a formally "correct" interpretation of art does not enhance the aesthetic experience above and beyond what a more subjective interpretation confers (Pelowski et al., 2017). Interestingly, expertise may lead individuals to report more dislike for art that they otherwise enjoy (Reber et al., 2004). As such, it seems that each individual has sufficient, albeit informal, "expertise" to interpret most works of art—consider, again, the opening anecdote on the impact of Kapoor's *Yellow* on the naïve viewer. In this example, a featureless yellow painting can invite sustained reflection and enjoyment to the extent that it calls upon meaningful episodes in one's life.

Autobiographical memory content in aesthetic experience

Comparatively fewer studies address the relationship between explicit memory and aesthetic experience. Lee et al. (2023) published cursory evidence of a common mnemonic advantage between aesthetic experience and self-referential processes. Using a recognition memory paradigm and 100 representational art images, paintings were best remembered if they were rated as highly beautiful or if participants employed a self-referential encoding strategy. These results were interpreted as an example of the self-reference effect on encoding in the visual aesthetics domain, which invokes the superior recall advantage for word items encoded in relation to the self (Craik & Tulving, 1975; Lockhart & Craik, 1990; Symons & Johnson, 1997).

The association between self-relevance and aesthetic experience finds additional support in the work of Vessel and colleagues (2023), who observed that "self-relevant" images, or those congruent with identity, memory, or interests, were rated as more aesthetically moving than images deemed irrelevant or only relevant to others. Furthermore, the autobiographically relevant dimension of self-relevance was identified as the strongest contributor to this effect in their study.

Outside of the visual arts domain, memory researchers interested in the vivid and involuntary reinstatements of emotional memories that occur while listening to music, or music evoked autobiographical memories (MEAMS), find that participants often seek aesthetic experiences for the very purpose of reinstating memories in an emotionally safe context (Janata et al., 2007; Juslin, 2013). MEAMs are popular among memory researchers for their reliable occurrence inside and outside the laboratory, elicitation by both familiar and novel songs, as well as their resistance to psychiatric and neurodegenerative memory impairment (El Haj et al., 2013; Belfi et al., 2016). Schulkind et al. (1999) found that the likelihood of retrieving a MEAM is correlated with the degree to which a song elicits an emotional response, and correspondingly, Janata et al. (2007) found that most MEAMs engender intensely positive emotions. Notably, older adults retrieved the most MEAMs and experienced the most positive emotion when listening to songs from their adolescences and early adulthoods (Schulkind et al., 1999). This span of years is also associated with a "reminiscence bump" for autobiographical memory retrieval, or the tendency for people to most readily retrieve memories of important life events from this period (Rubin et al., 1988; Krumhansl & Zupnick, 2013).

Although the aesthetic experience outcomes of reactivated autobiographical memories during music listening are discussed less frequently than basic emotional outcomes such as sadness and joy, this may reflect differences in the functional uses of music and individuals' psychological categories. Juslin (2013) suggested that a listener must, consciously or unconsciously, categorize and attend to a song as "art" to experience emotions or judgments directed at the aesthetic properties themselves of music. Whether a song's aesthetic qualities are attended to, while influenced by external factors (e.g., prestige of the venue), are thought to be subjective. Juslin and Isaksson (2014) found that participants considered *expression, emotional arousal, originality, skill, message,* and *beauty* to be most important criteria in categorizing a song as art. This suggests that songs are more likely to engender aesthetic experiences when they invoke higher-order cognitive and emotional evaluations, and songs are additionally more likely to invoke such evaluations if they are first subjectively appreciated as "art." This cycle may reflect a mutual facilitation between memory and aesthetic experience in the musical domain similar to that which is proposed at present in the visual arts domain, further encouraging direct inquiry into this relationship.

The present studies

In the present studies, we narrow in on the role of autobiographical memory retrieval in the feeling of being aesthetically moved by visual art. We envision memory retrieval to be a conscious but spontaneous process that occurs during abstract art viewing as individuals work to interpret perceptual and conceptual ambiguity. In three studies, participants were shown a set of abstract painting images contributed by a single artist. The task had two phases: an "aesthetic phase," wherein participants provided ratings of how moving they found the images, and a "memory phase," where they indicated if an image cued a specific autobiographical memory. Between Studies 1 and 2, we varied the order of the aesthetic and memory phases to determine the extent to which our instructions influenced behavior in Study 1, where memories were recorded first. Given our interest in whether the coupling between autobiographical memory and aesthetic experiences occurs spontaneously outside of the laboratory,

the aesthetic-first condition was introduced to assess the strength of the relationship between aesthetic ratings and memory retrieval when aesthetic ratings are provided prior to any mention of autobiographical memory. Finally, Study 3 replicated our two task order conditions and extended our findings by testing whether the instructions in our memory cuing task could be deployed unilaterally to increase aesthetic ratings for all 32 painting stimuli. This condition tested whether spontaneity was necessary in the relationship between memory retrieval and aesthetic experience, or if it was sufficient to encourage an "autobiographical frame of reference" while viewing paintings.

To ensure that participants were recalling memories of specific times and places in their lives, we adapted an autobiographical memory cuing paradigm from Rubin (1982) that prompted participants to write down three words that identified that memory to them. We modeled our dependent variable, how "moving" participants found the art pieces, after the scale used in Vessel et al. (2013), which is inclusive of aesthetic emotions across valence and arousal spectra, ranging from beautiful, to interesting, to bizarre.

Study 1

Method

Participants

Of the 50 recruited, data from 42 participants (23 women; ages 18–55 years) were analyzed in our initial study. Two participants were excluded upfront due to inactivity, and six were later removed from data analysis for reporting no autobiographical memories. A two-tailed sensitivity analysis in G*Power showed that a sample size of 42 would be sufficient to detect a medium effect size of 0.62 between both means with power of 0.8 and alpha = 0.05 (Faul et al., 2007). All participants were native English speakers residing in Canada, the UK, or the USA and were recruited online through Prolific (Prolific.io). Informed consent was obtained prior to the start of the study, per the Duke University Campus Institutional Review Board, and participants were compensated $3 for their 15-min contribution.

Stimuli

Participants viewed 32 abstract paintings by Dr. Sharda Umanath, selected from a larger set of 200 paintings (see Etsy portfolio; Umanath, n.d.). These paintings were created for personal use and have never been reproduced, thus minimizing the chance of preexperimental exposure. Paintings were chosen to avoid representational or symbolic content as well as resemblance to others in the final set. To eliminate experimenter bias in the selection of the final set, we passed the remaining images through ResMem, a machine learning algorithm that predicts "intrinsic memorability" of images (Needell & Bainbridge, 2022). The final 32 paintings were selected to possess an evenly distributed range of ResMem scores, given that we had no hypothesis about the impact of this factor. The study was built on and hosted by Gorilla (gorilla.sc; Anwyl-Irvine et al., 2020).

Procedure

There were two phases to the study: first, the memory cuing phase (henceforth referred to as "memory phase") and second, the aesthetic rating phase ("aesthetic phase"). After giving informed consent, participants were told that they were participating in a study of autobiographical memory, which is "memory for events in your life that [they] could specify as occurring at one particular time and place." They were told that they would view abstract paintings for 8 s each, and to press "Yes" or "No" based on whether the paintings evoked an autobiographical memory during the eight seconds of viewing.[1] To control viewing duration, each painting remained on the screen for 8 s regardless of when the response of "Yes" or "No" was made. Selecting "Yes" prompted a free-response text box in which participants described the cued memory with the instruction that "Two or three words are sufficient (enough to be meaningful to [them])." After reading the instructions, participants answered a multiple-choice attention-check question: "What are you expected to do while viewing the paintings?" The correct answer was, "view the paintings and retrieve memories." The painting order was randomized for all participants.

After completing this task for all 32 paintings, participants proceeded to the aesthetic phase. They were told the following:

> Now that you have viewed all of the paintings, we want to know how these paintings made you feel. Were you moved by any of them? Being moved by a work of art means that you may have found it beautiful, compelling, or powerful. In the final section of this study, you will see the same paintings as you did before. This time, please rate them on the basis of whether you find them moving. Paintings you found beautiful can be moving, but not always: If you found a painting "pretty" but not particularly interesting or stirring, you

[1] We chose 8 s of viewing duration as a midpoint between the 5 s given for aesthetic ratings in Vessel et al. (2023) and the 10 s given to retrieve autobiographical memories from cue words in Rubin (1982).

may give it a low rating. Likewise, if a painting resonates with you despite you finding it bizarre or ugly, you may still give it a high rating.

Participants saw the 5-point Likert scale, ranging from 1 (*unmoved*) to 5 (*deeply moved*), and completed an attention check question: "Can a strange or bizarre painting move you?" The correct answer was, "yes." Participants completed 32 rating trials, with the 5-point Likert scale presented directly below the image on the screen (Fig. 1).

Data analysis

Data were visualized and analyzed in the R programming environment (Version 4.3.2; R Core Team, 2023). To determine the effect of cued memories (yes or no) on aesthetic ratings of paintings (1–5), we fit several linear mixed models (LMMs) that included *memory* as a fixed effect and combined random slopes and intercepts for paintings and participants. The maximal model (prior to model selection) included the following parameters:

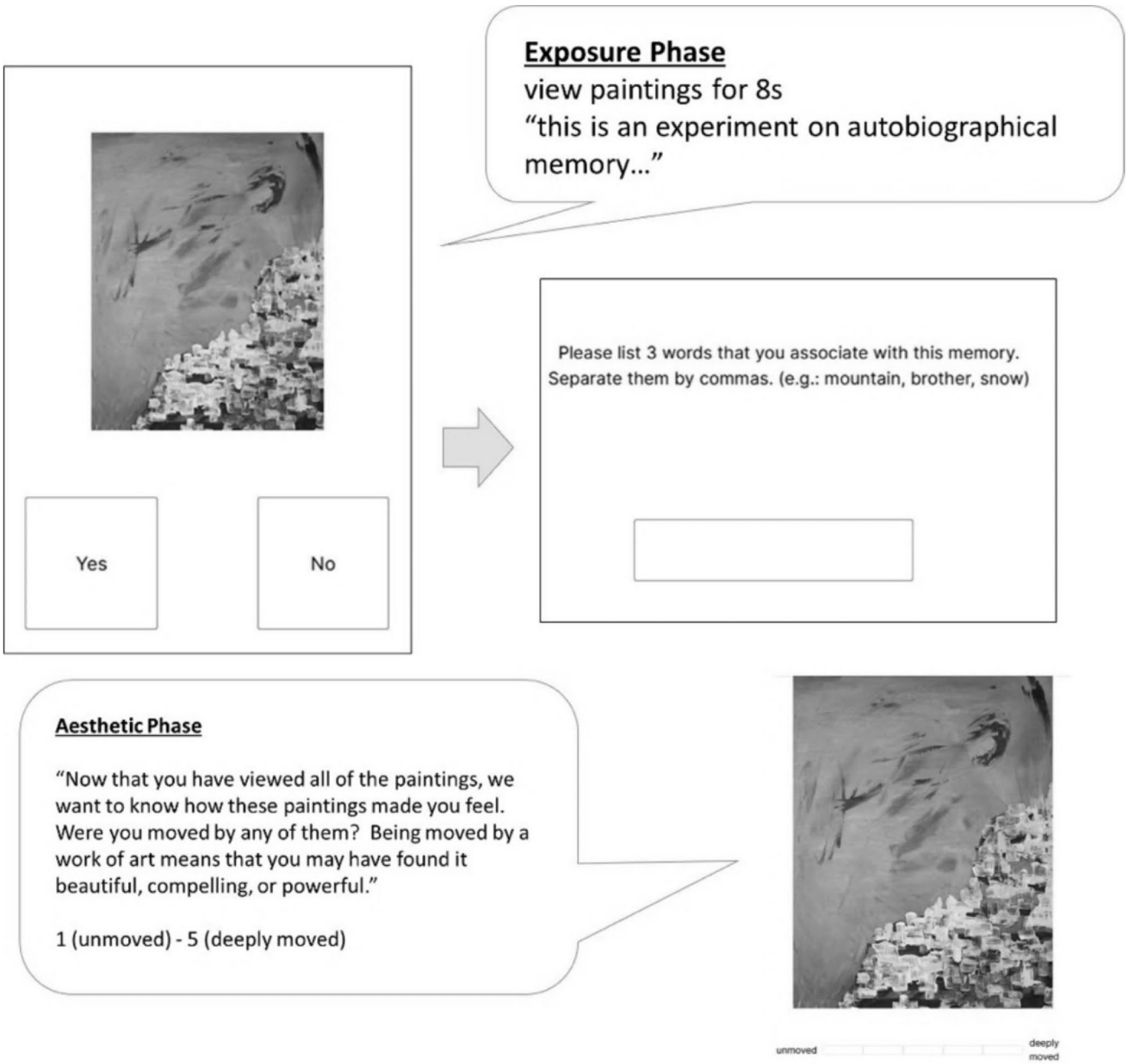

Fig. 1 Task procedure

$$aesthetic\ rating \sim 1 + memory + (1 + memory|participant) + (1 + memory|painting) + (1|participant) + (1|painting)$$

By removing random effects and omitting models that failed to converge, we selected the best-performing model by comparing the Akaike Information Coefficients (AIC) of the remaining candidates. Using likelihood ratio tests, we then examined the effect of memory cuing by comparing our model to a reduced version that omitted the fixed effect of *memory*.

Results and discussion

On average, participants reported autobiographical memories for 23% of the paintings presented (i.e., 7.4 memories per person, $SD = 5.4$). Responses often referenced a close other, a location, and an activity, such as "sister, bedroom, talk" and "zoo, night, daughter." Other cue words that corresponded to autobiographical memories described general atmospheres and locations, such as "night, grandma, stormy," "kimono, museum, whispers," and "Chinatown, San Francisco, fabric store."

Memory cuing frequency was normally distributed across the sample and is visualized as proportions of all trials in Fig. 2. Six participants reported retrieving no memories and were omitted from subsequent data analysis. Overall, average aesthetic ratings fell at the center of the 5-point scale ($M = 2.55$, $SD = 1.30$). Participants rated paintings that cued memories as significantly more aesthetically moving ($M = 3.36$, $SD = 1.32$) than paintings that did not ($M = 2.36$, $SD = 1.22$); $t(40) = 11.61$, $p < .001$ (Fig.3). The effect size, calculated as Cohen's d, was large ($d = 0.81$).

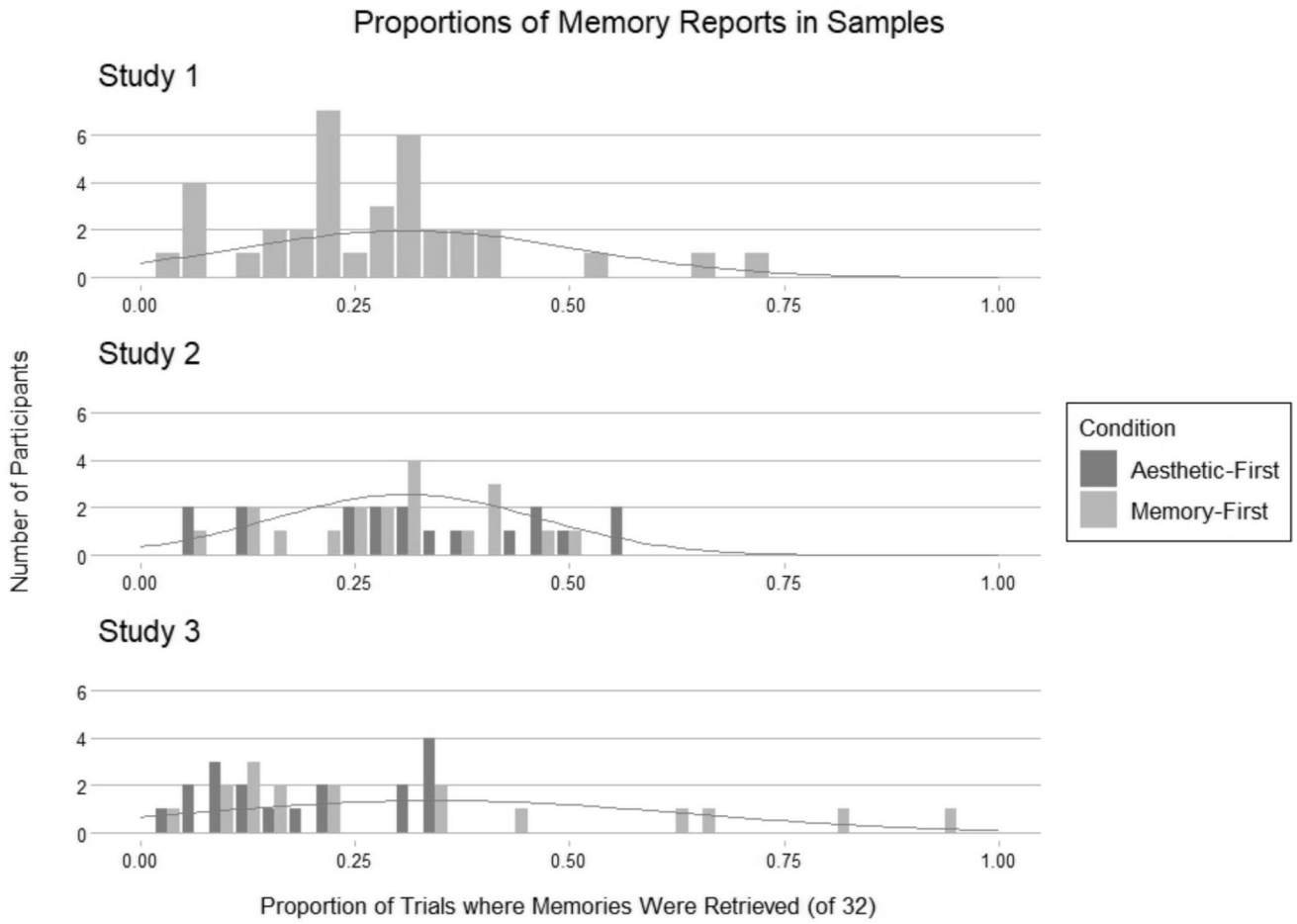

Fig. 2 Proportions of memory reports in samples

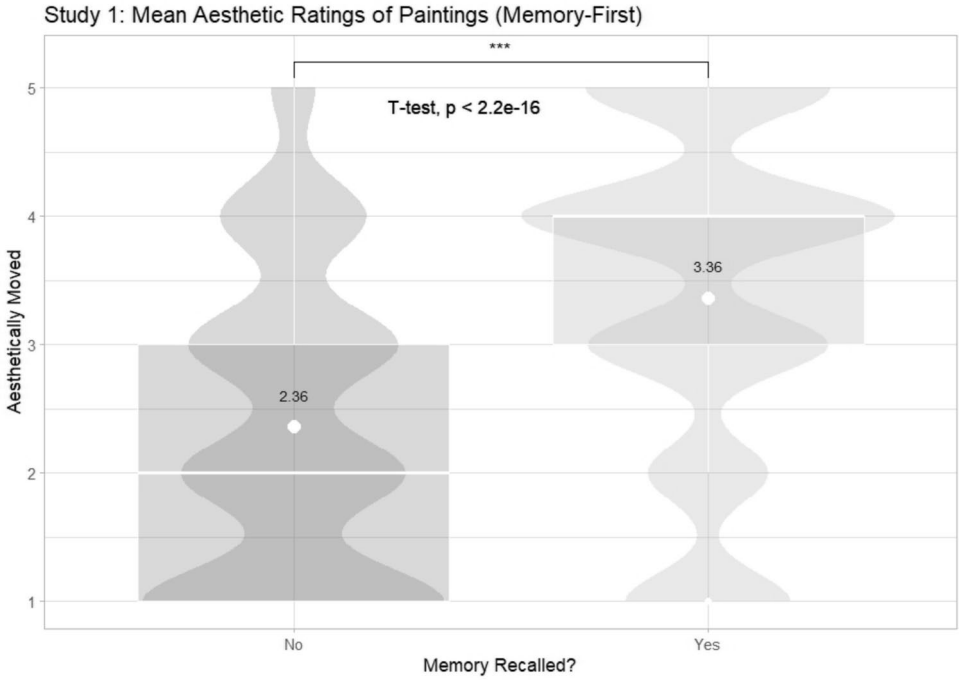

Fig. 3 Violin plots of mean aesthetic ratings (out of 5) for paintings that did cue a memory compared with those that did not in Study 1

Of the candidate models described above, comparison using AIC estimated at 99.8% relative likelihood that a model with a fixed effect of *memory*, random intercept for *painting*, and a random slope for *participant* was the best fit for our data:

$$aesthetic\ rating \sim 1 + memory + (1|painting) + (1 + memory|participant)$$

Estimation from the summary output indicated that aesthetic ratings associated with a memory were 0.98 of a point higher than those unassociated ($\widehat{\beta} = 0.97$, $SE = 0.14$, $t = 7.07$, $p < .001$). This model also significantly outperformed a reduced model that did not include memory retrieval as a fixed effect, $\chi^2(1, N = 42) = 32.08$, $p < .001$. These results support the hypothesis that participants were significantly more moved by paintings that cued a personal memory.

Study 2

Study 1 indicated that paintings associated with autobiographical memories were rated as significantly more moving, but it is unclear the extent to which the procedure encouraged that association. That is, the association between memory retrieval and aesthetic experience may not naturally arise in the absence of our task instructions. To examine this possibility, Study 2 added a new condition where a separate group of participants made baseline aesthetic ratings *prior* to indicating whether the paintings cued autobiographical memories ("aesthetic-first"). This condition was compared to a group which replicated the procedure of Study 1, where memory reports were made prior to aesthetic ratings ("memory-first"). To the extent that our procedure drove the effect, more memories should be retrieved in the memory-first condition than in the aesthetic-first condition, with a stronger relationship between memory retrieval and aesthetic ratings. In contrast, if aesthetic experience implicates spontaneous memory retrieval irrespective of our task instructions, we predict a comparable number of memories to be retrieved by participants in the aesthetic-first condition, and consequentially, a similar relationship between memory retrieval and aesthetic rating.

Method

Participants

Following Study 1, we expected a medium-to-large effect size and aimed to recruit 20 participants per condition. Of a total 48 participants recruited on Prolific, nine had technical difficulties and one participant reported no autobiographical memories. Resultingly, data from 39 participants were included in the analyses. Nineteen participants participated in the memory-first replication condition (ten women, nine men), and 20 participated in the additional aesthetic-first condition (11 women, nine men). All participants were

between the ages of 18 and 55, spoke English as their first language, and resided in the USA. Each received $3 for the 15-min study.

Procedure

Study 2 used the same 32 abstract artworks as Study 1. Participants were assigned either to the memory-first or aesthetic-first condition, which differed only in the order of memory cuing versus aesthetic rating phases. The memory-first condition replicated the procedure of Study 1 and the aesthetic-first condition asked for aesthetic ratings first and memory reports second. As in Study 1, aesthetic ratings were self-paced and used a 5-point scale (1 = unmoved; 5 = *deeply moved*). In the memory phase, participants also had 8 seconds to indicate if each painting cued a memory and subsequently input three words to identify that memory.

Results and discussion

Overall, participants reported an average of 8.9 memories (28%) in the memory-first condition and an average of 11.2 memories (35%) in the aesthetic-first condition (Fig. 2). Replicating and extending Study 1, aesthetic ratings in the memory-first condition were significantly higher for paintings that elicited memories ($M = 3.10$, $SD = 1.35$) than those that did not ($M = 1.98$, SD=1.17), $t(19) = 9.0$, $p < .001$). At Cohen's $d = 0.92$, this effect size was large. Critically, this effect was also present when aesthetic ratings were provided prior to reporting memories (aesthetic-first condition), such that paintings that elicited memories were later rated as more moving ($M = 3.24$, $SD = 1.31$) than those that did not (Fig. 4; $M = 2.43$, $SD = 1.32$), $t(18) = 6.2$, $p < .001$. This effect size was medium-to-large-sized ($d = 0.62$). Furthermore, a two-way analysis of variance (ANOVA) yielded significant main effects of condition, $F(37) = 25.28$, $p < .001$, $\eta^2 = .10$, and memory, $F(37) = 126.84$, $p < .001$, $\eta^2 = .02$, and no interaction between condition and memory, $F(37) = 3.05$, $p = .081$.

Linear mixed models

To again account for variation in participants and paintings, we fitted a set of candidate LMMs to each condition separately (to replicate Study 1 analyses), as well as together. In the memory-first condition, to replicate Study 1, an LMM that included a fixed effect of *memory*, a random intercept for *painting*, and a random slope for *participant* fit the data best according to AIC model selection (at 71.2% of the relative likelihood):

$$aesthetic\ rating \sim 1 + memory + (1|painting) + (1 + memory|participant)$$

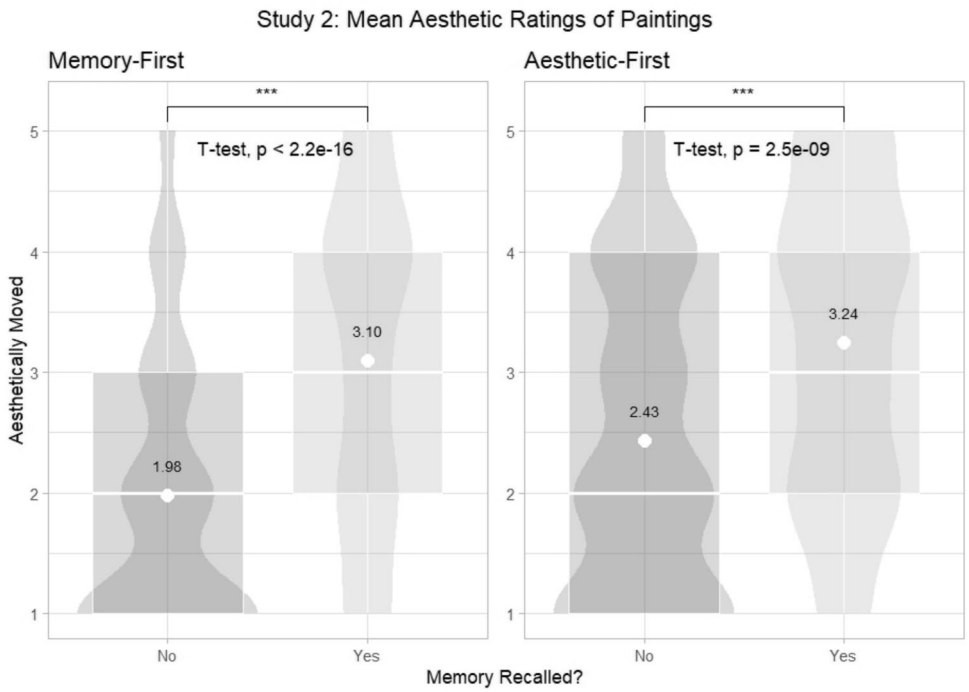

Fig. 4 Violin plots of mean aesthetic ratings (out of 5) for paintings that did cue a memory compared with those that did not in Study 2

For data from the Aesthetic-First condition, a model with a fixed effect of *memory* and random intercepts for *participant* and *painting* fit best (at 78.9% of the relative likelihood):

$$aesthetic\ rating \sim 1 + memory + (1|painting) + (1|participant)$$

Both full models significantly outperformed reduced models that omitted *memory* as a predictor, $\chi^2(1, N = 20) = 64.36$, $p < .001$, and $\chi^2(1, N = 19) = 35.09$, $p < .001$, respectively.

To test for an interaction after accounting for random variation, we ran candidate LMMs on the pooled data from both conditions. We found that an LMM that included fixed effects of *memory* and *condition*, an interaction term between *memory* and *condition*, a random intercept for *painting*, and a random slope for *participant* performed best (AIC likelihood = 64.7%).

$$aesthetic\ rating \sim 1 + memory + condition + memory * condition + (1|painting) + (1 + memory|participant)$$

This model yielded a significant main effect of *memory*, such that memory retrieval was associated with an estimated 0.64-point increase in associated aesthetic ratings ($\widehat{\beta} = 0.6$, $SE = 0.19$, $t = 3.43$, $p = .002$). There was no main effect of *condition* or significant interaction; as such it did not outperform an identical model that excluded the interaction effect, $\chi^2(1, N = 39) = 3.02$, $p = .082$.

Study 2 showed that participants who had an autobiographical memory cued while viewing a painting rated that painting as, on average, more moving than paintings that did not cue memories. This effect was present when participants were asked to report their evoked memories both prior to and after providing their ratings of aesthetic movingness. These results are in line with our hypothesis that autobiographical memory cuing occurs spontaneously, positively influencing aesthetic ratings independent of task order. However, the trending significance of *condition* reflected a slightly larger effect of memory cuing in the memory-first condition, which may belie an undetected group difference or a significant amplification interaction between *condition* and *memory*. One notable limitation of this study is the uneven number of memories registered between conditions. Therefore, we sought to replicate our findings in Study 3 before offering further interpretation.

Study 3

Study 3 sought to replicate and extend the findings of Study 2. A third condition was added, in which participants were instructed to retrieve memories for all paintings. This condition ("forced-memory") was included to assess the importance of spontaneity in memory retrieval for the relationship between memory and aesthetic experience. If participants in the forced-memory condition rate paintings highly after providing memory reports for all trials, it might suggest that our task helped them access meaningful interpretations of the paintings, regardless of whether those memories would have arisen without prompting. Conversely, if providing memory reports for all paintings produces lower aesthetic ratings, it may be that pairings between paintings and reported memories cannot be forced and that memory retrieval and the feeling of being moved must co-occur spontaneously.

Method

Participants

We recruited 65 participants from Prolific between the ages of 18 and 55. Participants were compensated $3 for the 15-min study. All participants spoke English as their first language and resided in the USA. Twenty-three participants participated in the memory-first condition (ten women, nine men), 20 participated in aesthetic-first condition (11 women, nine men), and 22 participants in the additional "forced-memory" condition. All participants were between the ages of 18 and 55, spoke English as their first language, and resided in the USA. Each received $3 for the 15-min study.

Procedure

The same stimuli used in Study 3 as in Studies 1 and 2. After giving informed consent, participants were randomly assigned to one of three conditions: "memory-first," "aesthetic-first," and "forced-memory." The first two conditions were identical to those run in Study 2. Participants in the forced-memory condition were explicitly required to retrieve a memory on each trial and were not allowed to select "no memory."

Results and discussion

On average, participants reported an average of 8.29 (25%) memories during the memory-first condition, 5.94 (19%) in the aesthetic-first condition, and 32 (100%) in the forced-memory condition (Fig. 2). The first two results replicated those of Studies 1 and 2. Memory cuing was significantly, positively associated with aesthetic ratings regardless of whether retrieval occurred before or after aesthetic ratings were made. In the memory-first condition,

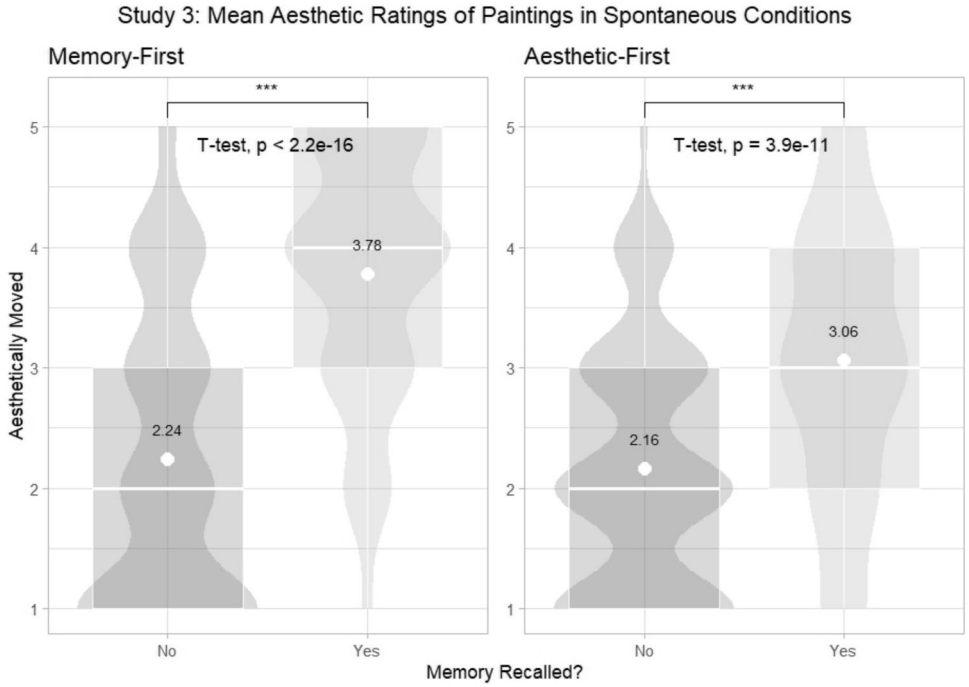

Fig. 5 Violin plots of mean aesthetic ratings (out of 5) for paintings that did cue a memory compared with those that did not in two "spontaneous memory" conditions of Study 3

the mean aesthetic rating was 2.24 (SD = 1.24) for paintings that were not associated with a memory and 3.78 (SD = 1.04) for those that were, $t(22) = 14.68$, $p < .001$. At over a 1/2-point difference, this effect size was very large ($d = 1.28$). In the aesthetic-first condition, paintings that were not associated with a memory were rated an average of 2.16 (SD = 1.04) compared with 3.06 (SD = 1.16) for those that were, $t(19) = 7.78$, $p < .001$. This result had a large effect size ($d = 0.84$). (Fig. 5). Whereas in Study 2 paintings that did not cue memories were rated slightly higher when ratings were solicited first, in Study 3 both conditions elicited similar mean ratings for paintings that did not cue memories.

In the forced-memory condition, the mean aesthetic response was 2.5 (SD = 1.42), which was significantly lower than the mean responses for paintings when memories were retrieved in the other conditions (Fig. 6), $F(2, 62) = 65.53$, $p < .001$, $\eta^2 = 0.12$, and slightly (but significantly) higher than the mean responses for paintings when memories were not retrieved, $F(2, 62) = 12.63$, $p < .001$, $\eta^2 = 0.01$. Given that the only difference between the forced-memory condition and the memory-first conditions was the choice to opt out of memory reporting during the first portion of the task, we used a t test to examine whether responses to both tasks overall (i.e., ignoring success of memory retrieval in the memory-first condition) differed significantly. The result indicates that they do not differ, $t(43) = 1.61$, $p = .11$, $d = 0.086$.

To investigate whether the responses to the forced-memory condition are distributed differently than the other conditions, and after ensuring normality, we performed three F tests on the three standard deviations, collapsed across all responses. We found that the memory-first and aesthetic-first responses deviated comparably; however, the forced-memory responses deviated considerably more than in the memory-first, $F(1, 703) = 1.85$, $p < .001$, and aesthetic-first conditions, $F(1, 703) = 1.49$, $p = .014$.

Linear mixed models

As in Studies 1 and 2, candidate LMMs were selected according to their AIC. In Study 3, for memory-first condition, an LMM that included a fixed effect of *memory* and random *painting* and *participant* slopes performed best and is presented below (AIC likelihood = 53.9%). The second most likely model replicated the model of memory-first condition of Studies 1 and 2 (likelihood = 39%).

$$aesthetic\ rating \sim 1 + memory + (1 + memory|painting) + (1 + memory|participant)$$

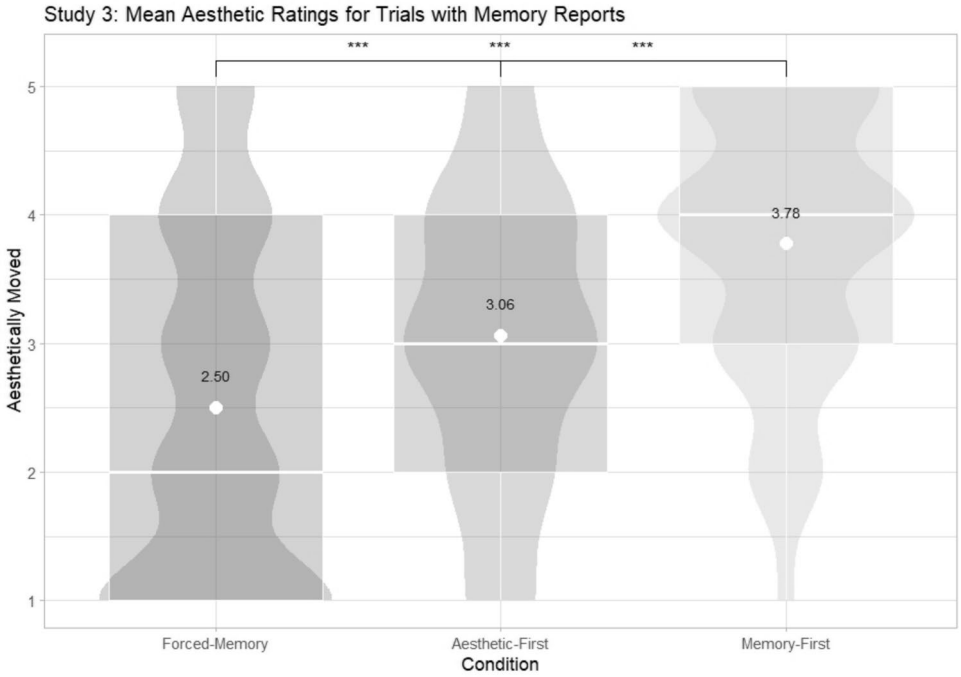

Fig. 6 Pairwise comparisons of mean aesthetic ratings in all Study 3 conditions. "Forced-memory" yields aesthetic ratings that are significantly lower than ratings for paintings that freely cue memory associations

For the aesthetic judgment first condition, an LMM that included a fixed effect of *memory* and random *painting*-specific and *participant*-specific intercepts performed best (AIC likelihood = 60.9%):

$$aesthetic\ rating \sim 1 + memory + (1|painting) + (1 + memory|participant)$$

These models significantly outperformed identical models that omitted *memory* as a fixed effect, $\chi^2(1, N = 23) = 56.79$, $p < .001$, and $\chi^2(1, N = 20) = 57.18$, $p < .001$, respectively.

Similarly, taken together, an LMM that includes fixed effects of *memory* and *condition*, an interaction term between *memory* and *condition*, a random intercept for *painting*, and a random slope for *participant* performed best (AIC likelihood = 66.7%):

$$aesthetic\ rating \sim 1 + memory + condition + memory * condition + (1 + memory|painting) + (1 + memory|participant)$$

This model estimates an increase of 0.75 points for paintings that cue memories ($\widehat{\beta} = 0.75$, $SE = 0.20$, $t = 3.85$, $p < .001$). The interaction term was also significant ($\widehat{\beta} = 0.54$, $SE = 0.26$, $t = 2.14$, $p = .04$); resultingly, this model slightly outperformed an identical model that omitted the interaction term, $\chi^2(1, N = 45) = 4.52$, $p = .03$.

General discussion

The present studies were designed to assess the extent to which spontaneous autobiographical memory retrieval predicts the feeling of being aesthetically moved by a work of abstract visual art. To this end, we showed participants a series of abstract painting images contributed by a single artist. Participants were given the opportunity to record memories retrieved during the 8-s viewing window as well as rate these paintings on the basis of how aesthetically moved they felt while viewing. Consistent with our predictions, we found that participants reported their strongest aesthetic experiences for paintings that spontaneously reminded them of a personal memory. To the extent that experimenter prompting drove the increase in aesthetic ratings after memories were explicitly reported, we predicted that this effect would disappear in a task where baseline aesthetic ratings were collected first. If,

however, memories are cued spontaneously during abstract art viewing irrespective of experimenter prompting, we predicted that paintings rated highly at baseline would also be associated with subsequent memory cuing. In support of the former proposition, the enhancement was observed whether memories were reported before or after aesthetic ratings were collected—an effect that replicated across all three studies. Furthermore, memory cuing was associated with aesthetic ratings that were, on average, nearly a full point higher on the 5-point scale: Specifically, memory cuing was associated with an average 1.16-point increase in feelings of being moved in the memory-first conditions and an average of 1.08 points in the aesthetic-first conditions. This suggests a mutually facilitatory relationship between aesthetic experience and autobiographical memory retrieval, potentially reflecting overlap in the cognitive processes recruited by these mental activities.

Effects of task condition

Consistent with the prediction that the mutual facilitation between autobiographical memory and aesthetic experience is invariant of task order, few quantitative differences between responses in the memory-first and aesthetic-first conditions reached statistical significance. The best-fitting mixed-effect models from each study estimated that both conditions were sampled from the same underlying distribution. Although the memory-first condition yielded consistently larger effect sizes, this trend presented inconsistently. In the memory-first condition of Study 1, memory retrieval success and failure predicted high and low aesthetic ratings, respectively. However, in Study 2, the larger main effect in the memory-first condition was primarily driven by lower ratings for paintings that did not cue memories. In Study 3, the effect of memory cuing was primarily driven by higher ratings for paintings that successfully cued memories. Although these results appear qualitatively to suggest that memory cuing prior to aesthetic rating influenced aesthetic ratings more strongly in both the positive and negative direction, the discrepancies between memory-first and aesthetic-first conditions were not sufficiently large to interpret.

In Study 3, the main effect of task condition meaningfully predicted aesthetic ratings insofar as it differentiated the forced-memory condition from the memory-first and aesthetic-first conditions, or the "spontaneous" memory conditions. Namely, participants in the forced-memory condition, who were required to report memories for all 32 trials, rated these paintings as significantly less moving overall. This suggests that choice is necessary in the relationship between memory retrieval and aesthetic experience. Additionally, low aesthetic ratings from the forced-memory condition demonstrate that simply priming self-relevant thinking is not only insufficient but is in fact counterproductive as an intervention to increase aesthetic experience unilaterally.

Interpretations from empirical aesthetics

Although spontaneous memory cuing is rarely discussed directly in the visual aesthetics literature, major theoretical frameworks in empirical aesthetics provide avenues through which to interpret these results. The Aesthetic Triad and the Vienna Integrated Model of Art Perception (VIMAP) propose that a continuously active network of self-relevant semantic knowledge, autobiographical memories, beliefs, and expectations that shape the structure and outcomes of aesthetic experiences (Pelowski et al., 2017). Referred to as the knowledge-meaning system in the aesthetic triad and the hierarchical self-image in the VIMAP, this "self-schema" is thought to organize and relate the majority of viewer-derived (or top-down) contributions to aesthetic experience (Chatterjee & Vartanian, 2014; Pelowski et al., 2017). In the VIMAP, the self-schema presides over the outcomes of cognitive appraisals, or "processing checks," that assess the level of self-relevance and interpretability (or "schema congruence") available to the viewer in a work of art. For example, a "bored" reaction is predicted of a painting deemed low in self-relevance but high in schema congruence, whereas the feeling of being aesthetically moved occurs when a painting is perceived as highly self-relevant and highly interpretable.

Based on this two-step appraisal structure, art that is consistent with one's expectations or is interpretable at face value could be perceived as facile or obvious or, in the case that it accords with the viewer's sense of self, powerfully resonant and even transformative (Pelowski et al., 2017). Specifically, the VIMAP outcome of "feeling aesthetically moved" that is targeted in the present studies rests upon automatic attributions of interpretability and self-relevance, which likely occur upon first exposure. Given that our painting stimuli were selected for roughly equal interpretability on a featural level, we suspect that the degree of subjective self-relevance determined whether participants engaged with our painting stimuli, driving aesthetic experience outcomes invariant of task order.

Interpretations from the memory literature

When aesthetic experience appears in psychological frameworks, it is often discussed as a higher-order phenomenon that guides learning behavior. For example, Fernández Velasco and Loev (2024) list aesthetic experience as a "metacognitive feeling" alongside feelings of knowing, confidence, and déjà vu. Put similarly, Silvia (2012) emphasizes the importance of the "knowledge emotions," or epistemic emotions, in appraisals of art, such as curiosity, interest, and

surprise. In personality psychology, sensitivity to aesthetic experience also appears as a facet of the openness/intellect trait, indicating that it reliably covaries with other behaviors originating from "a desire to explore the world cognitively, through both reasoning and perception" (DeYoung, 2015, p. 6). This positioning of aesthetic experience as a process that structures information-seeking behavior to interpret artwork accords with the present finding that the feeling of being moved is bidirectionally related to memory retrieval.

In the *levels of processing* literature, integrating word items into the self-schema during encoding is shown to confer the self-reference effect, which is associated with improved free recall performance at test above and beyond that of other semantic encoding strategies (Craik & Tulving, 1975; Lockhart & Craik, 1990; Symons & Johnson, 1997). The explanation for the success of this word memorization strategy is similarly based on the conceptualization self-schema as a centralized semantic network possessing high degrees of both *elaboration* and *organization.* In other words, self-relevant memories can be recounted and expanded upon in greater detail and are easily cued as a result of their situatedness among related concepts and memories (Klein & Kihlstrom, 1986).

Given that the forced-memory condition did not produce a "superior advantage" to aesthetic experience outcomes despite relating each trial to a personal memory, one potential concern is that participants' aesthetic ratings were anchored in a source of relative distinctiveness unrelated to self-referential processes (including an underlying phenomenology of feeling aesthetically moved) across all conditions. However, we suspect that the act of reporting memories for all trials did not produce a "self-reference effect" on aesthetic experience due to the comparative difficulty in coercing abstract paintings into perceived self-relevance compared to single word items. Resultingly, removing the choice of whether to report memories may have created a mental set wherein participants no longer perceived the task, on the whole, as an exercise in self-relevance. Comparatively, participants who were afforded the choice in whether to report memories likely distinguished "true" self-relevant items, facilitating access to detailed and meaningful personal memories that furnished their aesthetic experiences.

The integrated model of autobiographical memory function by Harris et al. (2014) synthesizes four core functions of autobiographical memory retrieval from adjacent clinical and cognitive literatures. First, memory serves a reflective function insofar as memories are recalled to more fully understand the self. Second, memory is social insofar as memories can be shared verbally or experientially. Third, memory is ruminative, insofar as memories can reengage us with sad experiences in the past. Finally, memory serves a generative function when it inspires or furnishes the content of creative products.

This framework highlights the growing understanding that memories are retained for their relevance to the present and future, in addition to the past. However, the ability to reinstate autobiographical memories for reflective, social, ruminative, or generative purposes may be difficult to accomplish at-will without the use of personalized memory cues.

Implications and future directions

Whether memory cuing is necessary or even sufficient experiencing the feeling of being moved, whether memory cuing factors into motivations to engage with art, and whether memory plays a functional role in arts engagement constitute mere selection of open avenues for future research in this area. Based on music research, however, there is reason to speculate that individuals engage with art, in part, for its capacity to bring forth personally meaningful autobiographical memories and accomplish functions outlined in the integrated model of autobiographical memory by Harris et al. (2014). For example, individuals' motivations for music listening, which were identified by Schäfer et al. (2013) as falling along the three dimensions of *mood regulation*, *achievement of self-awareness*, and, to a lesser extent, *achievement of social cohesion*, all recruit self-knowledge and autobiographical memory. Although motivations do not necessarily bear on aesthetic experience outcomes or evaluations, emotions stirred while listening to music are likely to originate from personal associations and episodes cued in the listener (Juslin, 2013). For instance, Schulkind et al. (1999) found that the intensity of positive emotion evoked while listening to music was correlated with whether that song cued an autobiographical memory in its listener (r =.43). Negative or mixed-emotional memories have also been discussed widely in relation to music and memory, as sad songs may aid in the regulation of mood and arousal by drawing upon memories of emotionally congruent or desired emotional states. A systematic review by Sachs et al. (2015) proposes that sad songs are experienced positively when they help listeners explore otherwise distressing emotions, resolve inner conflicts, distract themselves, or recall specific memories.

As it stands, future research might investigate the specific attributes of memories cued by art to determine the extent to which these domains of aesthetics can be compared. For instance, if visual art similarly exhibits a "reminiscence bump" of cued memories from youth, there is reason to suspect that evoked memories have featural and thematic similarities in both visual and musical domains. Furthermore, drawing upon autobiographical memory frameworks, aesthetic experience could be investigated in relation to its ability to serve reflective, social, ruminative, or generative

ends. While such memory functions may not be the primary motivation to engage with art, their outcomes may nevertheless contribute to the satisfaction and meaning derived from aesthetic experiences. By understanding which memories most strongly drive aesthetic responses and how, we draw closer to an integrated understanding of the role of art in well-being and the implications of aesthetic experience as a form of "recreational memory retrieval."

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Please see open practices statement.

Data Availability The data and materials for all experiments are available online (https://osf.io/vwtsg/) and by request, None of the experiments were preregistered.

Declarations

Ethics approval This project received ethics approval from the Duke University Campus IRB, approval number 2023-0157.

Consent to participate Informed consent was obtained from all participants included in the study.

Consent for publication Not applicable.

Conflicts of interest The authors have no relevant financial or non-financial interests to disclose.

References

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods, 52*(1), 388–407. https://doi.org/10.3758/s13428-019-01237-x

Beermann, U., Hosoya, G., Schindler, I., Scherer, K. R., Eid, M., Wagner, V., & Menninghaus, W. (2021). Dimensions and clusters of aesthetic emotions: A semantic profile analysis. *Frontiers in Psychology, 12*, Article Article 667173.

Belfi, A. M., Karlan, B., & Tranel, D. (2016). Music evokes vivid autobiographical memories. *Memory, 24*(7), 979–989. https://doi.org/10.1080/09658211.2015.1061012

Berlyne, D. E. (1973). Aesthetics and psychobiology. *Journal of Aesthetics and Art Criticism*. https://doi.org/10.2307/429334

Bornstein, R. F. (1989). Exposure and affect: Overview and meta-analysis of research, 1968–1987. *Psychological Bulletin, 106*(2), 265.

Chatterjee, A., & Vartanian, O. (2014). Neuroaesthetics. *Trends in Cognitive Sciences, 18*(7), 370–375.

Chen, Y. C., Chang, A., Rosenberg, M. D., Feng, D., Scholl, B. J., & Trainor, L. J. (2022). "Taste typicality" is a foundational and multi-modal dimension of ordinary aesthetic experience. *Current Biology, 32*(8), 1837–1842.

Craik, F. I., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General, 104*(3), 268–294.

DeYoung, C. G. (2015). Openness/intellect: A dimension of personality reflecting cognitive exploration. In M. Mikulincer, P. R. Shaver, M. L. Cooper, & R. J. Larsen (Eds.), *APA handbook of personality and social psychology, Vol. 4. Personality processes and individual differences* (pp. 369–399). American Psychological Association. https://doi.org/10.1037/14343-017

Dokic, J. (2016). IV—Aesthetic experience as a metacognitive feeling? A dual-aspect view. *Proceedings of the Aristotelian Society, 116*(1), 69–88.

El Haj, M., Clément, S., Fasotti, L., & Allain, P. (2013). Effects of music on autobiographical verbal narration in Alzheimer's disease. *Journal of Neurolinguistics, 26*(6), 691–700.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods, 39*(2), 175–191.

Fernández Velasco, P., & Loev, S. (2024). Metacognitive feelings: A predictive-processing perspective. *Perspectives on Psychological Science, 20*(4), 691–713. https://doi.org/10.1177/17456916231221976

Harris, C. B., Rasmussen, A. S., & Berntsen, D. (2014). The functions of autobiographical memory: An integrative approach. *Memory, 22*(5), 559–581.

Iigaya, K., Yi, S., Wahle, I. A., Tanwisuth, K., & O'Doherty, J. P. (2021). Aesthetic preference for art can be predicted from a mixture of low- and high-level visual features. *Nature Human Behaviour, 5*(6), 743–755.

Janata, P., Tomic, S. T., & Rakowski, S. K. (2007). Characterisation of music-evoked autobiographical memories. *Memory, 15*(8), 845–860. https://doi.org/10.1080/09658210701734593

Juslin, P. N. (2013). From everyday emotions to aesthetic emotions: Towards a unified theory of musical emotions. *Physics of Life Reviews, 10*(3), 235–266.

Juslin, P. N., & Isaksson, S. (2014). Subjective criteria for choice and aesthetic judgment of music: A comparison of psychology and music students. *Research Studies in Music Education, 36*(2), 179–198.

Klein, S. B., & Kihlstrom, J. F. (1986). Elaboration, organization, and the self-reference effect in memory. *Journal Of Experimental Psychology: General, 115*(1), 26–38. https://doi.org/10.1037/0096-3445.115.1.26

Krumhansl, C. L., & Zupnick, J. A. (2013). Cascading reminiscence bumps in popular music. *Psychological science, 24*(10), 2057–2068.

Landau, M. J., Greenberg, J., Solomon, S., Pyszczynski, T., & Martens, A. (2006). Windows into nothingness: Terror management, meaninglessness, and negative reactions to modern art. *Journal of Personality and Social Psychology, 90*(6), 879–892. https://doi.org/10.1037/0022-3514.90.6.879

Leder, H., Carbon, C. C., & Ripsas, A. L. (2006). Entitling art: Influence of title information on understanding and appreciation of paintings. *Acta Psychologica, 121*(2), 176–198.

Lee, H., Jacquot, A., Makowski, D., Arcangeli, M., Dokic, J., Piolino, P., & Sperduti, M. (2023). The beauty and the self: A common mnemonic advantage between aesthetic judgment and self-reference. *Psychology Of Consciousness: Theory, Research, And Practice, 11*(1), 71–81. https://doi.org/10.1037/cns0000345

Lockhart, R. S., & Craik, F. I. (1990). Levels of processing: A retrospective commentary on a framework for memory research. *Canadian Journal of Psychology/Revue Canadienne De Psychologie, 44*(1), 87–112. https://doi.org/10.1037/h0084237

Menninghaus, W., Wagner, V., Hanich, J., Wassiliwizky, E., Kuehnast, M., & Jacobsen, T. (2015). Towards a psychological construct of being moved. *PLoS One, 10*(6), Article Article e0128451.

Millis, K. (2001). Making meaning brings pleasure: The influence of titles on aesthetic experiences. *Emotion, 1*(3), 320–329. https://doi.org/10.1037/1528-3542.1.3.320

Montoya, R. M., Horton, R. S., Vevea, J. L., Citkowicz, M., & Lauber, E. A. (2017). A re-examination of the mere exposure effect: The influence of repeated exposure on recognition, familiarity, and liking. *Psychological Bulletin, 143*(5), 459–498. https://doi.org/10.1037/bul0000085

Needell, C. D., & Bainbridge, W. A. (2022). Embracing new techniques in deep learning for estimating image memorability. *Computational Brain & Behavior, 5*(2), 168–184. https://doi.org/10.1007/s42113-022-00126-5

Pelowski, M., Markey, P. S., Forster, M., Gerger, G., & Leder, H. (2017). Move me, astonish me … delight my eyes and brain: The Vienna Integrated Model of top-down and bottom-up processes in art perception (VIMAP) and corresponding affective, evaluative, and neurophysiological correlates. *Physics of Life Reviews, 21*, 80–125.

R Core Team. (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. http://www.R-project.org/

Ramachandran, V. S., & Hirstein, W. (1999). The science of art: A neurological theory of aesthetic experience. *Journal Of Consciousness Studies, 6*(6–7), 15–51.

Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? *Personality and Social Psychology Review: An Official Journal of the Society for Personality and Social Psychology Inc, 8*(4), 364–382. https://doi.org/10.1207/s15327957pspr0804_3

Rubin, D. C. (1982). On the retention function for autobiographical memory. *Journal of Verbal Learning and Verbal Behavior, 21*(1), 21–38. https://doi.org/10.1016/S0022-5371(82)90423-6

Rubin, D. C., Wetzler, S. E., & Nebes, R. D. (1988). 12 Autobiographical memory across the lifespan. *Autobiographical Memory*, 202.

Sachs, M. E., Damasio, A., & Habibi, A. (2015). The pleasures of sad music: A systematic review. *Frontiers in Human Neuroscience, 9*, Article Article 404.

Schäfer, T., Sedlmeier, P., Städtler, C., & Huron, D. (2013). The psychological functions of music listening. *Frontiers in Psychology, 4*, Article 511.

Schindler, I., Hosoya, G., Menninghaus, W., Beermann, U., Wagner, V., Eid, M., & Scherer, K. R. (2017). Measuring aesthetic emotions: A review of the literature and a new assessment tool. *PLoS One, 12*(6), Article e0178899.

Schulkind, M. D., Hennis, L. K., & Rubin, D. C. (1999). Music, emotion, and autobiographical memory: They're playing your song. *Memory & Cognition, 27*(6), 948–955. https://doi.org/10.3758/BF03201225

Silvia, P. J. (2012). Curiosity and motivation. In R. M. Ryan (Ed.), *The Oxford handbook of human motivation* (pp. 157–166). Oxford University Press.

Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: A meta-analysis. *Psychological Bulletin, 121*(3), 371–394. https://doi.org/10.1037/0033-2909.121.3.371

Umanath, S. [PaintsHerDreams]. (n.d.) Retrieved November 30, 2023, from https://www.etsy.com/shop/PaintsHerDreams

Vessel, E. A., & Rubin, N. (2010). Beauty and the beholder: Highly individual taste for abstract, but not real-world images. *Journal of Vision*, *10*(2), Article 18. https://doi.org/10.1167/10.2.18

Vessel, E. A., Pasqualette, L., Uran, C., Koldehoff, S., Bignardi, G., & Vinck, M. (2023). Self-relevance predicts the aesthetic appeal of real and synthetic artworks generated via neural style transfer. *Psychological Science, 34*(9), 1007–1023.

Vessel, E., Starr, G., & Rubin, N. (2013). Art reaches within: Aesthetic experience, the self and the default mode network. *Frontiers in Neuroscience*, *7*. https://doi.org/10.3389/fnins.2013.00258

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology, 9*(2, Pt.2), 1–27. https://doi.org/10.1037/h0025848

Zajonc, R. B. (1984). On the primacy of affect. *American Psychologist, 39*(2), 117–123. https://doi.org/10.1037/0003-066X.39.2.117