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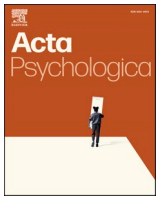

The effect of temporal context on memory for art☆

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ABSTRACT

Although considerable research has been done on memory for temporal information, as well as on the relationship between context and cognition, not much is known about the influence of temporal context on memory formation and retention. In this study, given that our sample comes from a largely Roman Catholic population, we used religious practices that occur throughout the calendar year to operationalize temporal context into two religious seasons (Lent and Ordinary Time). In addition, we used religious art to assess experience and memory as a function of whether there was temporal congruity or incongruity. This allowed us to explore different levels of memory representation; namely, memory for perceptual details of the art, memory for more inferential understanding of the art, and autobiographical memory for the initial experience of the art. Participants viewed 22 representational and abstract artworks during either Lent or Ordinary Time. After viewing, memory was tested at immediate, 1-day, and 7-day delays. We expected that the congruent temporal context (i.e., Lent) would lead to more activated semantic knowledge, which would then aid memory encoding and retention. This was the case only for perceptual details of the art. In addition, during Lent, forgetting followed a more linear pattern. These results suggest that priming semantic knowledge through temporal context leads encoding to focus on low-level information, as opposed to the processing of more complex information. Overall, these findings suggest that temporal context can influence cognition, but to a limited extent.

Context is a critical aspect of human cognition. In vision, the Ebbinghaus illusion shows how the perception of an object's size depends on the relative sizes of other objects in the field of view (c.f. Münsterberg, 1900). In hearing, linguistic context can aid word identification (e.g., Kintsch & Mross, 1985). In attention, objects that are inconsistent with scene context are prioritized (e.g., Loftus & Mackworth, 1978; Võ & Henderson, 2009). In memory, information is easier to remember when the encoding and retrieval contexts match (e.g., Godden & Baddeley, 1975). Moreover, changes from one context to the next disrupt memory, as when walking through doorways causes forgetting (Radvansky & Copeland, 2006). In all these examples, context is defined physically within some set of stimuli (shapes, words, or objects) and/or the physical situation in which the observer views those stimuli. Such contexts are therefore often defined using terms such as spatial context, as with environment-specific learning (e.g., Smith et al., 1978), or linguistic context, as with paired-associate learning (Calkins, 1894).

The current study aimed to explore the influence of *temporal context* on memory creation and retention. In framing this issue, it is important to distinguish the effects of memory *for* temporal information from the effects of temporal information *on* memory because he latter is our focus here. Studies of how time is encoded into, and retrieved from, episodic memory have a long history. Indeed, Tulving (1972, 1983) considered time to be an organizing prinicple of episodic memory with people using mental time travel to access both spatial and temporal information regarding their past experiences. Such temporal organization allows us to remember when a specific event occurred as well as the order of events over time (see Block & Gruber, 2014).

Not only can specific temporal information be retrieved, doing so can influence the retrieval of other memories. For example, perceiving or

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recalling one item facilitates the recall of others that were experienced close in time (Kahana, 1996), a principle called *contiguity*. Based on such findings, time can be considered to be a form of context that guides memory access. For example, in their *temporal context model* of memory, Howard and Kahana (1999, 2002) argued that when an item is recalled, others experienced at the same time are collectively retrieved, constituting a temporally-based contextual representation that is used as a cue to probe memory. As a result, those items that were experienced near in time to the just-remembered item are recalled next (see Polyn et al., 2009a for a generalized account of this principle).

1. Current study

Here, we assessed whether and how an event's temporal setting affects later memory. Time can be encoded precisely (it happened at noon), relativistically (it happened before dinner), and categorically (it happened during winter). Here, we were interested in categorical influences. In contrast to the work discussed above, we defined temporal context not in terms of the temporal relations between memoranda, but as the relationship between memoranda and the period of time in which they are experienced. Our hypothesis was that different temporal contexts are more likely to activate some types of associated content relative to less-related content. For example, in winter, concepts of snow and cold-weather apparel may be facilitated relative to the beaches and swimsuits associated with yearned-for summer months. If particular periods of time prime associated semantic structures, the processing of associated/congruent content could be facilitated. Because of this, when encountered information is *temporally congruent* with a context, engagement and memory for it could be aided compared to when information is *temporally incongruent*.

To study the effects of temporal context on memory, we leveraged natural contingencies in religious practices that take place at different points in the year to ask how the time period during which objects are encountered—in this case works of sacred art—affect how they are thought about and remembered. Art provides a rich testbed for investigating temporal context and the parameters that govern its influence. First and foremost, art portrays story/meaning which can be more or less consistent with the time period in which it is viewed. Our hypothesis was that different temporal contexts, operationalized here as different times of the liturgical year, are more likely to activate mental content associated with them and strengthen memory for related information.

To test this, we assessed experience of, and memory for, sacred art that was viewed during two temporal contexts in the Roman Catholic calendar. At different times in this calendar, different stories become more or less salient (e.g., Jesus' crucifixion at Easter versus a Sunday in July). We selected artworks that depicted religious stories related to the life of Jesus, focusing on the events surrounding his trial, execution, and resurrection. These are the events that are emphasized during the 40-day Christian season of *Lent* that culminates in the celebration of Easter. Many Christians, including Catholics, typically consider Lent to be a time of heightened spiritual discipline characterized by daily devotionals, fasting, and/or voluntary renunciation of a pleasure or luxury. Additionally, church decorations are often minimalized, ornate objects such as candlesticks and crosses are replaced with simple alternatives, flowers are not used, statuary is often removed or covered, and clergy vestments are dark purple. Lent therefore provides a visually, behaviorally, conceptually, and spiritually salient temporal context that is distinct from *Ordinary Time*, which is the 33–34 week period in the Church calendar during which the liturgy focuses on Biblical events other than Jesus' birth, trial, crucifixion, and resurrection. Thus, Lent served as our *temporally congruent condition* and Ordinary Time served as our *temporally incongruent condition*. By conducting this study at a Catholic university, we were able to recruit a sample that had substantial prior knowledge of (or at least exposure to) both the depicted stories and the different times of the liturgical year. Thus, temporal context here was easily identified, and our participants were embedded in the changing religious seasons.

In addition to enabling a manipulation between portrayed meaning and temporal context, our use of visual art as memoranda had two other advantages. First, art is both perceptual and conceptual, allowing us to consider the effects of temporal context at different levels of representation. Second, art can range from highly pictorial to very abstract, allowing us to explore how effects of temporal context may depend on differing degrees of cognitive analysis. We discuss these factors next.

1.1. Memory types

Memories of experiences are captured in different ways and at different levels of abstraction. For instance, in text comprehension, information can be represented in terms of its surface form (verbatim memory) and inferences (event models), each with different qualities (e.g., Radvansky & Zacks, 2014; Schmalhofer & Glavanov, 1986). Consider the sentence "The little porch was hidden from view by overgrown shrubbery." A verbatim representation would be an identical copy of the sentence. On the other hand, event model representations incorporate related, inferred, but not provided, information that targets a deeper understanding of the scene. This can include knowledge that the porch is attached to a house, that the shrubs are part of a planting bed, and that the owners do not enjoy gardening. Similarly, in vision, superficial understanding is indexed by perceptual memory for details (color, size, angles, object identities, etc.) and such understanding should be stable across people. More interpretive understanding is indexed by a gist understanding. For instance, "This depicts human suffering."

Capitalizing on the idea that art communicates information in the piece itself as well as the inferences drawn during comprehension, we assessed memory in multiple ways. First, we considered *perceptual memory* for visual experiences, such as the colors of objects in the artworks. Second, we examined *gist memory*, which included information about the inferences people generated when viewing the art, such as the depicted emotions, symbolic elements, or abstract ideas they believed were conveyed by the art. Third, we additionally considered *autobiographical memories* of the experience with a piece of art. We focused on remembered feelings of engagement when a piece of art was viewed, as well as how it impacted the viewer and how that personal impact was remembered.

We predicted all forms of memory would be enhanced by temporal congruence. That is, people would better remember perceptual details, gist, and the autobiographical experience during a temporally congruent context. This stems from work on transfer appropriate processing, an important concept for thinking about how context influences memory (Roediger & Blaxton, 1987). The basic idea is that retrieval can be influenced by the context of our thoughts during learning. In line with the encoding specificity principle, memory is better when retrieval uses mental processes aligned with those used at learning. For example, bilinguals better remember things when the language used at encoding and retrieval are the same (Marian & Neisser, 2000). From this perspective, different seasons of a calendar are likely to lend themselves to different types of thinking. Specifically, semantic / episodic / autobiographical information that is congruent with the current temporal context is more likely to be activated and used to comprehend and process information. Given this, we predicted that in temporally congruent contexts, people would be more likely to apply knowledge activated by their ongoing experience of a particular season in a calendar year to the encoding and retrieval of materials at the time of their participation. Thus, we expected people to have better memory when the temporal context was congruent with the art than when it was not.

1.2. Artistic style

For this project, representational and abstract art pieces were used because they elicit different cognitive processes (Schepman & Rodway, 2021). In general, representational artworks elicit better comprehension

and stronger emotional responses than abstract ones (Leder et al., 2012; Schepman et al., 2015a). Not surprisingly, people's reported understanding of abstract art is aided more by the inclusion of titles that convey what a piece is about (Leder et al., 2006), and people's responses are more consistent for representational than abstract art (Schepman et al., 2015b). People also use different language to describe the different styles, such as using more concrete words to describe experiences of representational art (Schepman & Rodway, 2021). Further, an asymmetry exists in that people prefer familiarity in representational art and novelty in abstract art (Song et al., 2021). Representational art more directly conveys to viewers the depicted events, whereas abstract art requires mental effort from the viewer to understand how the work refers to the labeled event.

We did not have strong predictions for how artistic style would be influenced by temporal context. Thus, analyses involving this factor were more exploratory. On the one hand, because representational art elicits stronger emotional reactions, it could be that processing such pieces would be more influenced by a congruent temporal context. On the other hand, because abstract art requires more effort to understand, it may be that the processing of such pieces would be more influenced by a congruent temporal context.

1.3. Retention interval

Finally, we tested memory at different delays: immediately, 1 day, and 7 days after viewing. An important quality of memory is that it changes over time (Ebbinghaus, 1885), but the nature and magnitude of these changes can vary depending on how various factors influence the processes of consolidation and retrieval (see, for example, Roediger & Karpicke, 2006; Staugaard & Berntsen, 2019; Wixted & Ebbesen, 1991). Additionally, recent work suggests that different levels of memory show different patterns of forgetting (Fisher & Radvansky, 2018; Radvansky et al., 2022). Information that is represented more simply in memory, and is not learned as well, tends to show more curvilinear loss patterns, such as power functions. In these cases, the forgetting curve is more extreme in the time soon after learning with a less pronounced decline later on. We expected this pattern to be associated with perceptual memory. In contrast, information encoded more deeply in memory, and has been learned well, tends to show more linear forgetting. We expected this to be more characteristic of gist memory. Thus, by testing memory across different delays, we were able to explore how temporal context, artistic styles, and memory types might be differentially affected by the passage of time.

In summary, we assessed memory for representational and abstract sacred art at perceptual, gist, and autobiographical levels of memory across three time points. We predicted memory across all levels of representation would be enhanced by a congruent temporal context. Because representational and abstract art differentially engage cognition, we explored the possibility of different patterns of performance for different art types, with no strong a priori predictions. We also expected more linear forgetting for gist levels of memory compared to perceptual levels.

2. Method

2.1. Participants

We recruited 153 undergraduate students (104 identified as female) from a selective private Catholic university in the United States to participate in the study. All participants were compensated with course credit. Informed consent was obtained from each person and the relevant university board approved all procedures.

2.2. Stimuli, materials, and apparatus

All participants viewed photographs of two existing art installations on the university's campus. While both installations depict core Christian narratives, they provide contrasts in location, medium, and style (see Fig. 1 for examples of each; the complete stimulus set is provided in Appendix A).[1] Luigi Gregori's *Stations of the Cross* (1874–77) is located in the Basilica of the Sacred Heart and is made up of fourteen panels painted in oil on wood that pictorially convey the Passion of Christ. This work is representational, with its depictions being easily recognized due to their resemblance to their physical counterparts. Philip Rickey's *The Life of Christ/Cycle of Life* (2017) is located in the Charles B. Hayes Family Sculpture Park and is composed of 70 stone megaliths arranged into 8 "scenes" set into a natural landscape that each suggest events and characters in the life of Jesus. These works are abstract as they do not provide an accurate depiction of reality but use shape, color, and form to convey narrative.

Each photograph was placed on a white background with a short title added at the bottom of the screen that identified the depicted event (e.g., Jesus accepts the cross, Jesus is nailed to the cross, etc.). These titles were used to disambiguate the event/narrative being depicted and to serve as a referent during later memory tests.

All parts of the study were conducted online using Qualtrics to display stimuli and collect responses. Thus, participants completed the study using their own devices and at locations and times of their choosing.

2.3. Design and procedure

Participants were assigned to one of two conditions based on the timing of their participation in the study. Participants in the *temporally congruent* condition ($n = 78$) participated during the 40-day season of Lent that precedes Easter. This is a liturgical season of prayer, fasting, and almsgiving in the Roman Catholic calendar that serves as a time of preparation to celebrate Christ's resurrection. Participants in this group completed the study between March 18 and April 20, 2022, or between March 27 and April 9, 2023. Participants in the *temporally incongruent* condition ($n = 75$) completed the study during Ordinary Time which encompasses the periods of time in the church calendar that do not include Lent/Easter or Advent/Christmas. Participants in this group participated between September 6 and October 8, 2022 or between February 13 and February 21, 2023.

These temporal contexts are ones many of our participants would have been cognizant of and would have sufficient semantic memory structures to make them meaningful. To emphasize the temporal context for our participants, prior to seeing the art pieces, they were either asked:

> "As the Easter season and Lent are about to start, how do you feel about this time of the year? If you and your family participate in services during Lent, how do you plan on participating this year? How do you think Easter will be celebrated in your school environment?"
>
> Or,
>
> "Now that we are in Ordinary Time in the church calendar, how do you feel about this time of year? If you and your family participate in services during Ordinary Time, how do you plan on participating this year? How do you think Ordinary Time will be evident in your school environment?"

The 22 art pieces were presented one after the other. The representational (paintings) and abstract (sculptures) were presented in separate

[1] We additionally selected these works of art because our original intention was to have participants view these art installations in-person. However, our campus was closed and students sent home during the COVID pandemic which forced us to conduct the experiment using online data collection methods.

Fig. 1. Examples of the representational (left) and abstract (right) art pieces used in this study. Both depict Jesus carrying the cross.

blocks in counterbalanced order across participants. Because the artworks depicted sequences of events in a chronological narrative (e.g. Jesus' trial preceded his crucifixion), within each block the stimuli were presented in the order in which the depicted events occurred (rather than, for example, a randomized order).

Participants were asked questions while viewing each piece. First, they were asked about the art itself. Perceptual questions focused on surface details (e.g., "How many halos are there in the painting?" or "What color is the stone representing the cross?") and others on a gist interpretation (e.g., "What do the standing pillars in the sculpture represent?"). Three perceptual- and three gist-based questions were asked for each piece (see Appendix A). Then, participants were prompted to self-report their own engagement with the art ("How emotionally engaging do you find this painting/sculpture?") as well as an estimate of how much they think other people would be engaged with the art ("How emotionally engaging would someone else who is affected find this painting/sculpture") using a 0–100 Likert scale.

Memory was tested over three delays: Day 0 (immediately after viewing the artworks), Day 1 (between 24 and 30 h after viewing), and Day 7 (one week after viewing). For Days 1 and 7, participants were sent email links to surveys with the memory questions. For each memory test session, a different set of 6–8 artworks was included. The pieces tested at each delay were counterbalanced across participants.

Memory for items was tested by first providing the name of an artwork to be recalled that matched the title given during initial viewing. Three memory questions (2 multiple choice and 1 short free-response; see Appendix A) focused on perceptual features and another three focused on gist. The multiple-choice questions each had 4 response alternatives. Additional questions were autobiographical and focused on prior reports of self and others' engagement ("Based on your memory, what was your engagement with this painting/sculpture when you first saw it?" and "Based on your memory, what do you think someone else's engagement with the painting/sculpture would be when they first saw it?"). All of these were measured on a 0–100 Likert scale. Participants were additionally asked to provide demographic information regarding religious identity; they were asked to provide their religious affiliation (Roman Catholic, Christian (non-Roman Catholic), None, or Other) and rate their involvement in their religion on a scale from 0 to 100. Finally, they were asked to rate their familiarity with the paintings and the sculptures, as well as their interest in art, on a scale from 0 to 100.[2]

3. Results

For our analyses, we first considered the characteristics of our sample. Second, we analyzed participants' experience while viewing the art as a function of temporal context. Third, we assessed memory by considering each of the levels of representation separately, namely perceptual, gist, and autobiographical memories. Fourth, we report our findings concerning memory retention over time. Fifth, we consider how initial engagement scores relate to later memory. Finally, we report notable influences of individual differences on responses. For expository reasons, we limit our discussion to main effects and statistically significant interactions; complete analyses are reported in Appendix B.

3.1. Sample characteristics

Due to coding errors, self-reported interest in art, religious involvement, religious affiliation, and familiarity with the art were not obtained from 53 people, (28 in the Temporally Congruent group). Given the random distribution of this error, the remaining 100 participants are assumed to be representational of the full sample.

The overwhelming majority of participants came from Christian religious traditions. Specifically, 69 (69 %) identified as Roman Catholic, 13 (13 %) as Christian (non-Roman Catholic), 16 (16 %) as None, and 2 (2 %) as Other. We expect that participants in the "None" and "Other" groups would nevertheless be familiar with the subject matter of

[2] At the conclusion of the experiment, participants were asked to complete several questionnaires. These included the Desire for Aesthetics Scale (Lundy et al., 2010), the Centrality of Religiosity Scale (Huber & Huber, 2012), and the Art Experience Questionnaire (Chatterjee et al., 2010). These questionnaires are designed to reveal the extent to which a person prioritizes aesthetically pleasing things in their environment, the importance of religion to an individual's personality and sense of self, and experience with art by measuring the time people dedicate to art-based activities. Due to low response rates ($n = 53$) we did not analyze this data.

the artwork given the strong Catholic nature of the university and the requirement that all students take courses that include critical study of the Bible and Christian traditions. Therefore, we did not break our sample down into Christian/Non-Christian subgroups. While religious identity was rather homogeneous, we observed substantial variability in self-reported religious involvement (Fig. 2) within the sample (M = 47.4, SE = 3.09). The sample was additionally varied in terms of self-reported interest in art (M = 44.6, SE = 2.50). Self-reported religious involvement in the congruent (M = 46.1) and incongruent (M = 33.5) temporal contexts did not statistically differ, t(98) < 1. There was also no statistical difference between self-reported interest in art in the congruent (M = 44.7) and incongruent contexts (M = 44.5), $t(98) < 1$.

Participants had more familiarity with the representational (M = 40.2, SE = 3.33) than the abstract art used in this study (M = 11.5, SE = 1.60). As can be seen in Fig. 3, the overall level of familiarity was low, with a restricted range, particularly for the abstract artworks. As such, we do not consider this factor further.[3] Later, in our Individual Differences section we assess the degree to which these values were related to our more primary measures.

3.2. Viewing experience

The data on self-reported feelings of engagement with the art during viewing was submitted to a 2 (Art Type: Representational, Abstract) x 2 (Temporal Context: Lent, Ordinary Time) ANOVA. The engagement scores for representational art (M = 55.6, SE = 1.83) were higher than those for abstract art (M = 31.8, SE = 1.70), $F(1, 151) = 238$, $p < .001$, $\eta_p^2 = 0.61$. Thus, participants felt more engaged when viewing the representational paintings. No effects of temporal context, however, were observed, both $ps \geq 0.56$. Thus, we did not obtain support for our prediction that people would feel more engaged with the art during temporally congruent contexts.

3.3. Memory

To understand how context affects memory, we separately considered memory for perceptual qualities, inferential gist, and autobiographical experience. Given that each of these is capturing theoretically different qualities of memory, they were assessed separately.

3.3.1. Perceptual memory

For perceptual details, a 2 (Temporal Context: Lent, Ordinary Time) X 2 (Art Type: Representational, Abstract) X 3 (Delay: 0, 1, or 7 days) ANOVA revealed that memory was better in the congruent temporal congruent (M = 0.48, SE = 0.01), than the incongruent context (M = 0.44, SE = 0.01), as evidenced by the main effect of Temporal Context, $F(1, 151) = 4.48$, $p = .04$, $\eta_p^2 = 0.03$. Thus, for perceptual details, memory was better when the temporal context was consistent with the semantic content of the art, suggesting semantic knowledge of the temporal context could be leveraged to support requisite memory processes. In addition, memory declined over time, $F(2,302) = 111$, $p < .001$, $\eta_p^2 = 0.42$, as expected (Fig. 4), although we delay our discussion of the form of this decline until later in the results. Perceptual memory was not affected by art type, $F(1, 151) < 1$. No interactions were statistically significant (p's 0.22–0.98; see Table A1.).

3.3.2. Memory for gist

For inferential gist, unlike perceptual details, a 2 (Temporal Context: Lent, Ordinary Time) X 2 (Art Type: Representational, Abstract) X 3 (Delay: 0, 1, or 7 days) ANOVA revealed no influence of temporal context, $F(1, 151) < 1$, $p = .40$, $\eta_p^2 = 0.005$. Gist memory declined over time, $F(2, 302) = 46.0$, $p < .001$, $\eta_p^2 = 0.23$, as expected (Fig. 5), an effect we describe in more detail in a separate section. Moreover, participants had better gist memory for abstract (M = 0.50, SE = 0.01) than representational art (M = 0.45, SE = 0.01), as evidenced by the main effect of Art Type, $F(1, 151) = 23.2$, $p < .001$, $\eta_p^2 = 0.13$, suggesting that for abstract art, people needed to spend more effort understanding what they were looking at, creating gist narratives that lead to better encoding. No interactions were statistically significant (p's 0.08–0.49; see Table A2.).

3.3.3. Memory for autobiographical experience

We assessed viewers' autobiographical memory for their initial experience. To do so, we combined their memory for their own engagement with the art with their memory for their own estimates of others' engagement into a single dependent variable by averaging each Likert-scale score (0−100). A 2 (Temporal Context: Lent, Ordinary Time) X 2 (Art Type: Representational, Abstract) X 3 (Delay: 0, 1, or 7 days) ANOVA was conducted (see Table A3.). There was no main effect of Temporal Context on autobiographical memory, $F(1, 151) < 1$, but temporal context interacted with Delay, $F(2, 302) = 5.06$, $p = .007$, $\eta_p^2 = 0.03$. For the incongruent temporal context, with longer retention intervals, participants tended to overestimate their initial engagement with the art. In contrast, for the congruent temporal context, memory for their level of initial engagement did not change (see Fig. 6). The stability of the temporally congruent context may be a result of both context and sample. This is because participants attend a Catholic university with active and accessible church services available, and so this sample is more likely to be attuned to the current temporal context. A Catholic participant regularly engaging with religious experiences may retain the feeling of engagement, and this effect may not replicate in a secular environment with secular or with a sample with a larger proportion of non-Christian religious students.

The main effect of Art Type was also significant. Participants overestimated their original level of engagement for the abstract art, and underestimated it for the representational art, $F(1, 151) = 60.8$, $p < .001$, $\eta_p^2 = 0.29$. Moreover, as can be seen in Fig. 7, while this difference was present at all delays, there was a larger change over the first 24 h for abstract art memories. This was supported by a Delay x Art Type interaction, $F(2, 302) = 7.92$, $p < .001$, $\eta_p^2 = 0.05$. Thus, memory for representational art experiences was slightly more veridical, than memory for abstract art. A possible reason for this may be that non-expert art viewers find abstract art more difficult to understand. The stone monoliths are missing many of the features (faces, colors, recognizable contextual objects) that make more representational art easier to parse. As a result, the initial experience was not as fluid and as easy to understand. However, memory traces are focused on retention of the greater story within the art as well as surface details. When recounting the story, it is possible that the art is retroactively felt to be better understood, and therefore assumed to have been more initially engaging.[4]

[3] It is worth noting that self-reported familiarity with the abstract art in the congruent (M = 8.96) and incongruent (M = 14.1) temporal contexts did not statistically differ, $t(98) = 1.60$, $p = .11$. A small familiarity difference was observed for the representational art in the congruent (M = 33.8) versus the incongruent (M = 46.6) context, $t(98) = 1.96$, $p = .05$. The cause of this difference is unknown, but its direction is counter to predicted memory advantages in the congruent context.

[4] Data for the incongruent condition was collected in two waves (in September – October 2022 and in February 2023), raising the possibility that cohort effects could differentiate the participants in each wave. We submitted perceptual, gist, and autobiographical memory to 2 (wave) x 2 (art type) x 3 (delay) mixed model ANOVAs. In no case did the main effect of wave reach statistical significance (all p's 0.40–0.84) nor did it interact with any other factor (all p's 0.19–0.99).

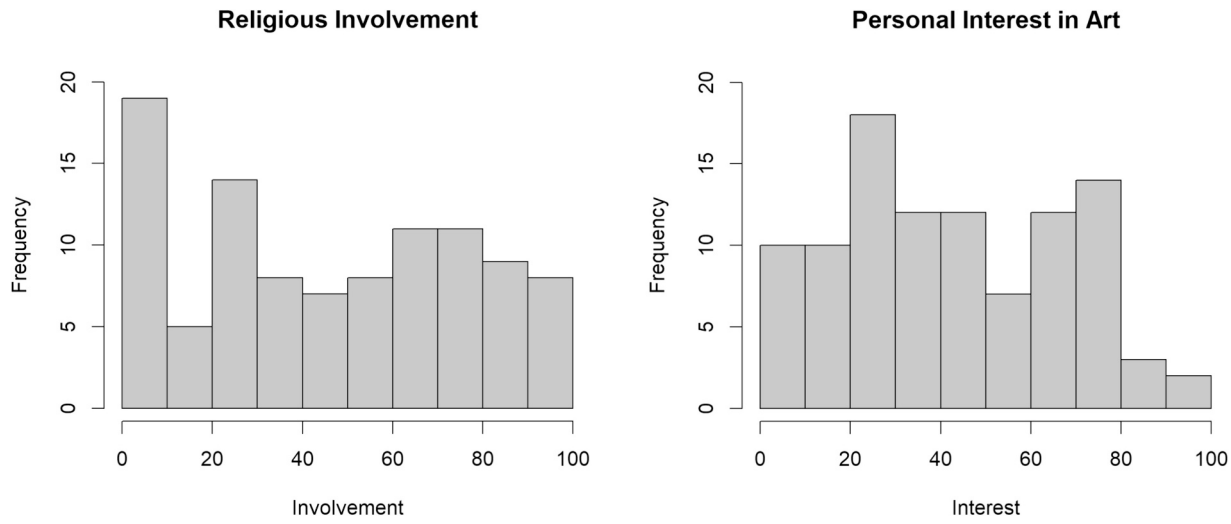

Fig. 2. Histogram of self-reported interest in art and religious involvement. In both cases 0 indicated "low" and 100 indicated "high."

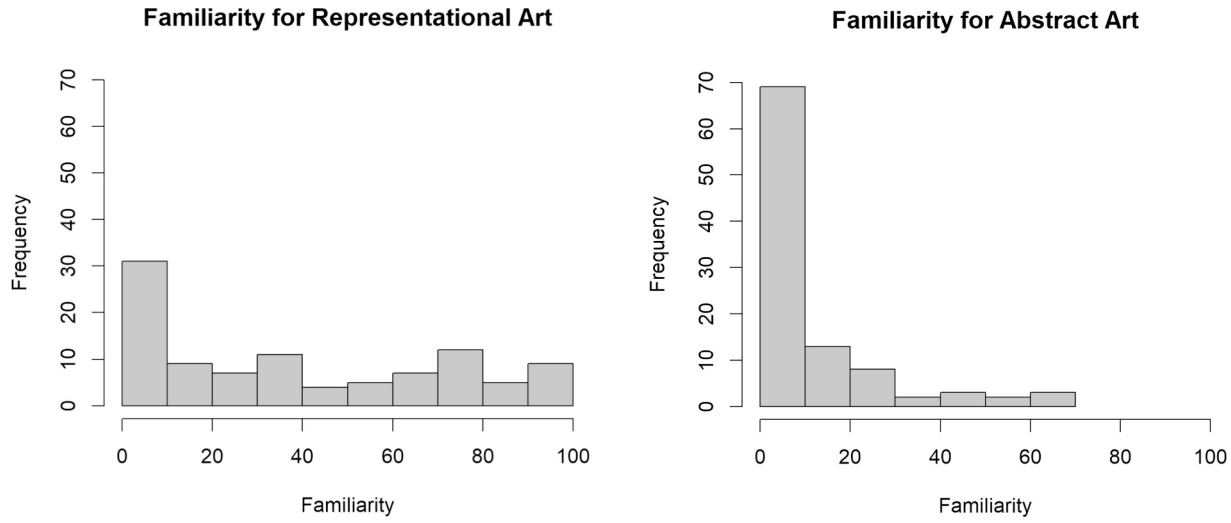

Fig. 3. Histogram of self-reported familiarity in representational and abstract art. In both cases 0 indicated "low" and 100 indicated "high."

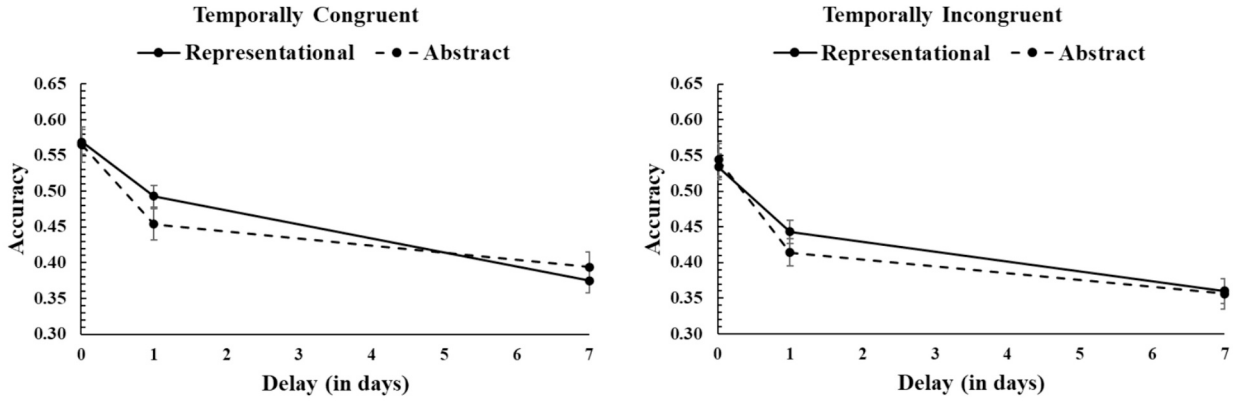

Fig. 4. Forgetting rates of perceptual details across temporal contexts and art types.

3.4. Retention over time

In the introduction we noted that different patterns of memory retention and forgetting can lead to qualitatively different loss functions. To address this, we fit power and linear functions to the loss data as a function of (a) Temporal Context, (b) Level of Representation, and (c) Art Type. The results of these fits are shown in Table 1.

Looking at the best fitting functions, during Ordinary Time,

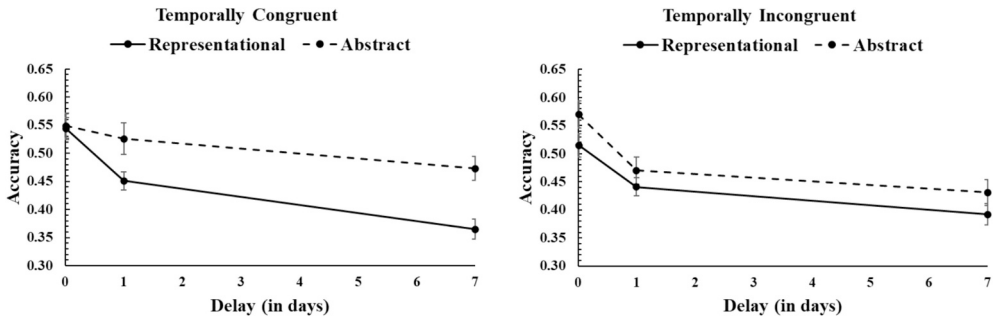

Fig. 5. Forgetting rates of inferential gist across temporal contexts and art types.

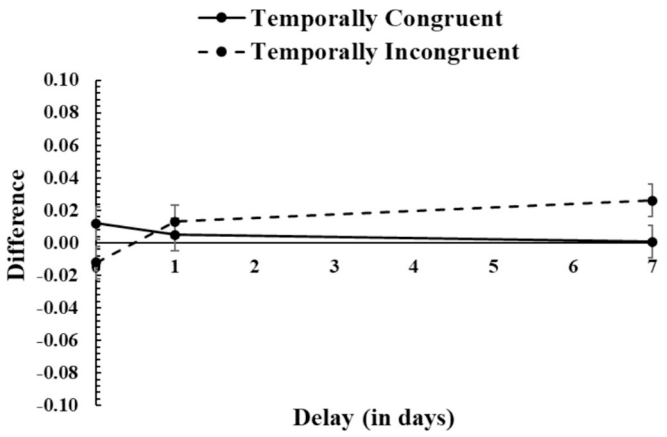

Fig. 6. Forgetting of prior engagement experiences across temporal contexts and delay.

regardless of the level of representation and the art type, the memory loss was best fit by a power function. However, during Lent, different patterns emerge. Specifically, half of the loss functions were better fit by a linear than a power function. Linear functions are more often associated with more complex, event level representations (Fisher & Radvansky, 2018). First, for representational art, we observed a more linear pattern of forgetting for perceptual details, but not for gist information. So, during Lent, when religious concepts are more likely to be activated, for this type of art, people may have been more likely to effectively encode and retain specific detailed information in the paintings. For example, they could have been more likely to use their understanding of the religious season to interpret specific details in the art, and relate them to the larger narrative. In comparison, for the abstract art, we observed a larger discrepancy in favor of linear loss functions, and in this case for the gist memory measures. This is consistent with the idea that abstract art requires more conceptual effort to understand than representational art (Leder et al., 2006). In this case, the Lenten season may have aided such a conceptual understanding, thereby strengthening these memory traces.

3.5. Engagement and memory

While we have considered how temporal context may have influenced initial engagement and memory for the art, we have not yet considered how different levels of initial engagement were related to memory (Fig. 8). A correlation analysis revealed that initial engagement ratings were correlated with gist memory, $r = 0.18$, $p = .03$. The greater the reported engagement, the better was a person's later memory of what the art was about. This may have occurred because greater

Table 1
Power and linear function r^2 fit values.

	Ordinary Time			
	Representational		Abstract	
	Perceptual	Gist	Perceptual	Gist
Power	0.93	0.98	1.00	1.00
Linear	0.84	0.76	0.61	0.67

	Lent			
	Representational		Abstract	
	Perceptual	Gist	Perceptual	Gist
Power	0.84	0.93	0.99	0.79
Linear	0.93	0.84	0.72	0.97

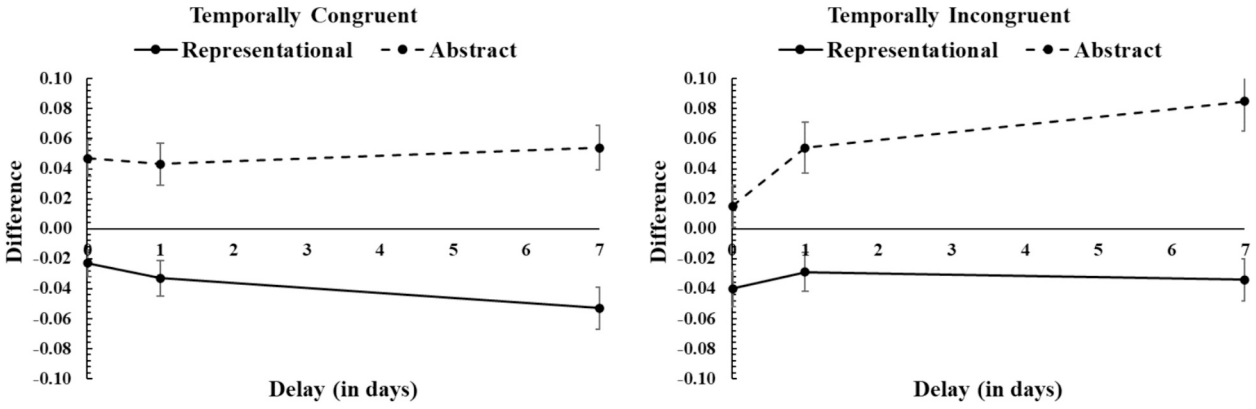

Fig. 7. Difference between memory of artwork engagement and original engagement across temporal contexts and delays. Positive values indicate an overestimation of previous engagement; negative values indicate an underestimation of previous engagement.

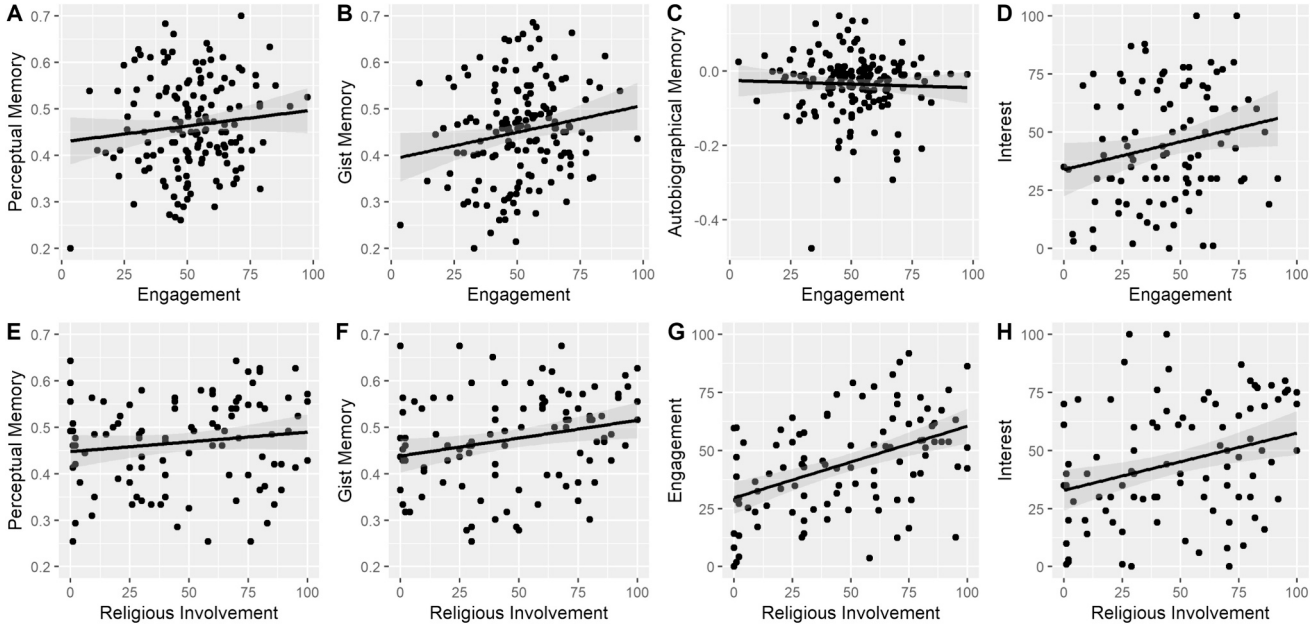

Fig. 8. Relationships between engagement, religious involvement, and memory.

engagement led to more effort in deriving inferences to understand what the art was about. The correlation between engagement and detail memory did not reach significance, $r = 0.13$, $p = .12$, although the trend was in the same direction. There was no relationship between engagement ratings and autobiographical memory, $r = -0.04$, $p = .64$.

3.6. Individual differences

To assess individual differences in performance, we had two primary measures of interest: (a) interest in art, and (b) involvement in religion. We consider each in turn (see Fig. 8).

In terms of interest in art, as noted in our description of our participants, there was quite a range among responses when participants were asked to indicate how interested they were in art (Fig. 2). First, reported interest in art was correlated with how engaged participants reported being when they viewed the individual pieces, $r = 0.20$, $p = .04$. Thus, participants who were more interested in art were also more likely to be affected by the pieces we presented. That said, this alignment with experiences of art did not translate into better memory performance, all *p*s > 0.50. Thus, interest did not drive later memory.

The other individual difference of primary concern here was religious involvement. Our measures of interest in art and religious involvement were correlated, $r = 0.30$, $p = .002$, with more religiously involved participants also showing a greater interest in art. The religious focus of the art in our stimulus sets may be responsible for this effect. Current studies that we are doing, which include non-religious art, will further test this finding. As with interest in art, religious involvement was correlated with reported engagement with the art, $r = 0.45$, $p < .001$, although here the relationship is much stronger.

Unlike interest in art, religious involvement was found to be correlated with some types of memory. Specifically, participants reporting greater involvement in their religion had better memory for the gist of what the art was about, $r = 0.24$, $p = .02$. Religious involvement did not, however, predict memory for perceptual details, $r = 0.13$, $p = .20$. Thus, the more involved people were with religion in their lives, the more likely they were to make inferences and use their world knowledge to interpret what they were seeing, and then incorporate this into their memories of the art.

4. Discussion

Time is an important component of episodic memory (Tulving, 1972, 1983). We can remember when events occurred as well as the relative order in which they were experienced (see Block & Gruber, 2014). Furthermore, accessing a specific memory can cue the recall of other memories that were encoded at similar points in time (Howard & Kahana, 1999, 2002; Polyn et al., 2009b). As such, time can serve as a form of context that cues prior memories. In the current study, we addressed a reciprocal question: Can a period of time in which an event is experienced (i.e., its temporal context) influence the formation and retention of memories for those events?

In our study, people viewed examples of sacred art that depict the events surrounding Jesus Christ's trial, crucifixion, and resurrection as described in the *Bible*. In a between-subjects manipulation, these works were viewed during the religious seasons of Lent and Easter (when these events are principally celebrated in Christian religions) or Ordinary Time (when liturgies focus on other events in Jesus' life and ministry). These served as temporally congruent and incongruent conditions. Our aim was to assess whether and how memory is influenced by the alignment of temporal context and the content of visual experience. We also explored how such influences might vary as a function of artistic style (representational and abstract), types of memory (perceptual, gist, and autobiographical), and retention interval (immediate, 1-day, and 7-day). We included these factors because representational and abstract art elicit different qualities of visual-semantic processing (e.g., Schepman & Rodway, 2021); perceptual, inferential, and autobiographical memory differentially capture how people process, retain, and retrieve information (e.g., Fisher & Radvansky, 2018); and assessing multiple retention intervals enables an analysis of forgetting over time.

We first assessed if temporal context influences initial experiences with the art. People reported their level of engagement with the artworks when they first viewed them. We did not obtain any evidence to suggest that temporal context affected initial engagement. Hence, any effects of temporal context on memory are not attributable to differences in initial engagement (e.g., depth of study). Instead, it would be due to the nature and content of the resulting memories.

We hypothesized that temporal contexts can evoke associated knowledge that can be used to scaffold and/or augment participants' processing and comprehension of art. As such, we predicted that

memory at all levels of representation would benefit from a congruence between temporal context and memoranda. This prediction held with respect to memory for perceptual details (i.e., what the art looked like), with better memory during our temporally congruent context of Lent/Easter than during our temporally incongruent context of Ordinary Time. However, memory for inferential gist was not affected by temporal context. These results together suggest that the knowledge that is activated during temporally congruent contexts had an influence on processing perceptual qualities, but did not affect the drawing of interpretive inferences.

When changes in perceptual and gist memory were evaluated over time, we observed evidence that temporal context can additionally influence patterns of retention and forgetting. Perceptual and gist levels of representation were affected by longer retention intervals, as expected (cf., Ebbinghaus, 1885). However, not all forgetting is the same. Different patterns reflect the use of different mental representations and processes (Fisher & Radvansky, 2018, 2022). In our temporally incongruent condition, memory loss was best fit by a power function for both levels of representation and both art types. Power functions reflect initially rapid forgetting that decelerates over time. This is typically observed when information is represented more simply in memory and/or not learned well. In contrast, for the temporally congruent condition, we more often observed linear forgetting. This is typically observed when the representation has greater complexity and/or has been learned well. Linear functions were found for perceptual memory of representational art and gist memory of abstract art.

Our observation that memory for perceptual details for representational art showed greater linear forgetting during our temporally congruent condition is consistent with our other observation that such memories are more likely to be retained within a congruent temporal context as well as our hypothesis that such contexts lead to greater activation of consistent knowledge. This aids encoding, freeing resources for perceptual analysis, and results in richer perceptual memories. This explanation also accounts for more linear forgetting of gist for abstract art. Again, temporally congruent periods may activate consistent knowledge, which is then used to draw inferences for what the art is about. This is needed more for abstract art where more conceptual effort is needed for understanding.

In addition to perceptual and gist memory, we considered the effects of temporal context on autobiographical memory for people's initial encounters with the arts. We assessed people's memory for their prior ratings of engagement while viewing the artworks. Temporal context influenced autobiographical memory over time. Specifically, as time passed since encoding, people more accurately remembered their engagement ratings for a congruent temporal context. In contrast, during the temporally incongruent context, people tended to overestimate their initial engagement ratings. It may be that a temporally congruent context elicits better retrieval cues (or heightened sensitivity to such cues) to access their prior autobiographical experiences. For temporally incongruent contexts, such cues are less available, and people may make judgements about their past experiences based on more general expectations (e.g., "art is supposed to be enjoyable, so I must have enjoyed it").

While our main focus was on the effects of temporal context, we obtained additional findings that more broadly describe participants' experiences with, and memory for, works of art. Beginning with engagement, we observed higher self-reported engagement with representational than abstract art. This difference is consistent with other research (Leder et al., 2012; Schepman et al., 2015a) and may occur because of the higher level of cognitive effort required to understand what an abstract piece is about. This effort may serve as a form of *desirable difficulty* that supports learning, comprehension, and remembering. (e.g., Bjork, 1994a, 1994b; Bjork & Bjork, 2020). Indeed, gist memory was also better for abstract art, suggesting that this increased effort led to more inference making as people tried to "decode" the meaning conveyed by the abstract art and generate mental models that combine externally provided information (e.g., a painting) along with inferences drawn from general world and autobiographical knowledge. These processes, ultimately, resulted in better memory for that meaning.

We also found that autobiographical memories of engagement were more positive for abstract art. In comparison, for representational art, people remembered themselves as being less engaged. This, again, may reflect initial cognitive effort. For abstract art, there are more likely to be cognitive operations associated with memories for the art. These may then lead to a more positive assessment of the experience (e.g., "if I thought about it more, I must have liked it more"). The opposite would be the case for representational art.

Finally, people can vary in their experience of materials as a function of their interests. We found that interest in art was correlated with their reported engagement when viewing the art, which is not surprising. This reported interest was not related to any of our other measures, except our other factor of interest, religious involvement. The religious focus of the study may well underlie this effect. It follows that people who are more religious may be more likely to report interest in art given that our artworks were sacred in nature. Moreover, religious involvement was positively correlated with later memory. This was driven by memory for inferential gist, as opposed to perceptual memory. Participants who were heavily involved in their religion may have had increased capability to connect viewed art to stories and information already in their memory. They may have been better able to use this existing knowledge to make connections and inferences when viewing the art, further improving memory.

The data patterns we have observed and the conclusions we have made, are limited in important ways, which indicate a need for additional study. First, while the manipulations of religious context provided a naturalistic way to parse time into temporally congruent and incongruent periods "in the wild," future work should seek to generalize our findings to a wider range of subject matter. Second, this study sampled a population that was largely experienced with the Christian faith and came from a Western educational background. Moving forward, expansions in both the subject matter of the art as well the participant sample, with an increased focus on participants from more diverse backgrounds, would be beneficial. Recruiting participants who are more experienced in consuming or creating art would also provide an important contrast to the largely novice audience in this study. Third, our measures of individual differences were admittedly limited. Future work continuing this line of questioning has introduced more robust individual differences metrics. Finally, in addition to generalizability across materials and people, it would be theoretically interesting to more specifically examine the effect of temporal context on different memory retrieval processes such as free recall, cued recall, and recognition by explicitly manipulating the form and structure test questions.

With limitations and future directions in mind, our study suggests that temporal context, the frame of time during which an event is experienced, can influence cognition. Memory processing is not only aided by perceptual, environmental, and mental contexts, it can also be aided through the activation of semantic information consistent with the current time frame. Importantly, this influence is limited, and does not have strong effects on a wide range of cognitive processes. It appears to involve greater processing of inferential information, which can then free up some cognitive resources for other tasks, such as encoding. This further supports the idea that cognition is embodied and embedded. How we process information, especially when there is room for ambiguity, as with art, can be influenced by the types of information that are consistent with the framework in which a person is embedded.

CRediT authorship contribution statement

Sean M. Dageforde: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Dani Parra:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Klaudia M. Malik:** Writing – review & editing, Data

curation. **Lucas L. Christensen:** Writing – review & editing, Methodology. **Robin M. Jensen:** Writing – review & editing, Project administration, Methodology, Funding acquisition. **James R. Brockmole:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Gabriel A. Radvansky:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors have no competing interests to declare.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2024.104349.

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