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Material Culture, Museums, and Memory: Experiments in Visitor Recall and Memory

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ABSTRACT

Approaches to the subject of memory vary considerably, according to discipline. Museologists have either focused upon the role of the museum as a memory bank, or examined memories of museum visits in relation to identity and motivations. Archeologists have investigated the use of memory to regulate community experience, whilst psychologists have developed experimental methods to assess the quantity and quality of information encoded and retrieved. Until now, few studies have attempted to draw evidence from across these fields to understand how different types of exhibits and sensory experiences contribute to individual memory formation. We therefore conducted controlled experiments with 64 adults to measure memory differences when archeological material was presented in three distinct formats (display case, virtual manipulation, and object handling). The study demonstrated greater recognition and recall when objects were handled, suggesting multisensory experiences improve memory for both the artifacts themselves and their associated “stories.” It indicated that descriptive label information is far more striking than object names or dates, and that artifacts depicting living creatures were recalled more easily than other objects. The most marked differences occurred in more challenging memory tasks, where immersive encoding and participant expertise acted independently to improve the quality of memory.

Introduction

The museum experience is a multi-layered journey that is proprioceptive, sensory, intellectual, esthetic, and social. The end result might be learning, wonder, reflection and relaxation, sensory stimulation, conversation with friends, new social ties, creation of lasting memories, or recollection of past events. (Levent & Pascual-Leone, 2014, p. xiii)

Scholars of material culture have engaged with memory studies in different and sometimes overlapping ways depending on their specific field of study. Archeologists have commonly focused on discussions of memory in terms of motivated attempts (religious, social, political) to regulate community experience or simply in terms of a reinterpretation of sites and artifacts. Museologists have often concentrated on the multiplicities of roles museums play in memory formation, while visitor studies have addressed impact and recall of the museum experience. This includes identifying what

is memorable about a presentation, the objects themselves or the personal/social dimensions of a museum visit. The first visitor studies of memory sprang from attempts to define and measure the types of learning occurring in museums (McManus, 1993). A key finding was the vividness and strong durability of memories from museums (Fivush, Hudson, & Nelson, 1984; Falk & Dierking, 1992; Falk, 2009). Scholars such as Tulley and Lucas (1991), Falk and Dierking (2000), and Medved and Oatley (2000) then demonstrated that when visitors acquired new knowledge in a museum or science center they could often transfer and use it in a subsequent “real world” situation if cued by similar stimuli. Psychologists have also shed light upon the processes of memory-making, highlighting the differences between “semantic memory” (relating to conceptual knowledge) and “episodic memory” (relating to personal experience of an event). The very personal nature of episodic memories means they are difficult to compare objectively, and they are thought to be more vulnerable to deterioration over time (McManus, 1993). However, studies by both Stevenson (1991) and Medved and Oatley (2000) showed that episodic memories of museum visits (namely descriptions of exhibits and what they did) were more stable and accurate than semantic memories concerning the scientific principles of the exhibits. Focusing upon visitor experiences of artworks, Medved, Cupchik, and Oatley (2004) further concluded that personal relevance and experience play a significant role in recollection, and which memories are constantly revisited and reorganized, in an effort to give meaning to the original encounter. Visitor studies to date have employed a range of techniques, including structured and unstructured interviews, questionnaires, and visitor tracking/observation. While they may produce qualitative data (e.g. Wolins, Jensen, & Ulzheimer, 1992) or quantitative data (e.g. Bitgood & Cleghorn, 1994) they are generally dependent upon a level of researcher-mediation sometimes criticized for introducing bias, especially where studies involve young children, who may be less self-aware or reflective than adults (Piscitelli & Anderson, 2001). In psychology, the majority of studies have been undertaken in laboratory conditions, using visual and linguistic stimuli rather than objects in a “real-world setting” (Fivush et al., 1984), so although significant insights have been gained through the studies outlined above, there is not yet an established methodology for integrating museum and psychology-based visitor studies of memory.

In other areas, analyses of the role of memory and material culture have seen increasing attention over the last few decades starting with scholars like Assmann and Czaplicka (1995) who set the agenda for examination of how different types of memory were used in society. Recent research foci have included analysis of expressions of memory through artifacts (Jones, 2007), use of memory in the process of religious change (Sweetman, 2015), the role of the senses in creating memories of past (Hamilakis, 2013). In museum studies, it is widely recognized that memory has a significant role in creating perceptions of the past and present (Arnold-de Simine, 2013; Black, 2011). And these memories are partly based on the curatorial choices made about what is presented and how artifacts are displayed in museums (Wilton, 2006, p. 58). Together, these different approaches have made beneficial contributions to theorizing how memories are formed through sensory engagements with material culture. However, to date, little empirical work has been undertaken on why there are divergent memories of a variety of material culture. As we will see below, some visitor studies suggest that the size or

unusualness of the exhibit may have a role to play in its memorability (Anderson, Piscitelli, Weier, Everett, & Tayler, 2002). But questions of whether or not memory is more or less enhanced by the medium in which the material is viewed or how this affects the ability to recall accompanying information have yet to be tested empirically. In particular, there are differences in opinion as to the significance of interactivity in enhancing memory. Some studies suggest that when there are opportunities for tactile and kinesthetic engagement alongside objects, their memorability is enhanced (Anderson et al., 2002; McManus, 1993) whilst others argue that recollections primarily center upon the objects themselves (Bitgood & Cleghorn, 1994; Piscitelli & Anderson, 2001; Stevenson, 1991; Wilkening, 2015). As digital provision becomes commonplace in museums it is important to assess how well it supports memory and learning, and what impact it has on visitor behavior, attention, and memory compared to other forms of interpretation. While this is moving forward in terms of STEM learning¹ where studies are examining how the medium of experience is impacting learning outcomes, museum studies are still quite focused on the value of digital media for accessibility and appeal. This is not always the case, but is often the catalyst for the very latest technological developments in museums, for example in the virtual recreation of the Battle of Bannockburn (at the Visitor Center there), visitors like the ability to control and be involved.² And while museum scholars have worked more recently to take different approaches to studies of digital engagement (Smith Bautista 2013), the development of the technologies is outpacing the assessment of their value, in part because of the focus on the study of the theoretical impact, rather than the actual. Stevens (2016) suggested the value of digital media in creating multi-sensory experiences, he argued that digital interactions could be haptic experiences even though the object was not materially present. In our own experiments (Sweetman & Hadfield 2018), adults felt strongly that the digital experience was not at all a multi-sensory experience but more akin to gazing at an object behind a glass case.

Museums are increasingly working to improve community well-being through programming and spaces that allow for relaxation, exercise, social contact and mental stimulation. In order to build upon the visitor studies outlined above, this article presents the results of a series of experiments that tested levels of recognition and recall when visitors encountered archeological material under three different display conditions: in a glass case, virtual manipulation, and handling of original artifacts. Our research outcomes have important implications for the design and development of stimulating and memorable visitor experiences at cultural heritage sites and museums. Furthermore, they will make a contribution to the growing area of material culture and dementia research and for the advancement of well-being programs in the heritage sector, by helping to inform the choice of interpretative tools for these purposes. Whilst it is common for museums to use their collections for reminiscence sessions with older visitors and those affected by dementia³, museums are currently using a range of approaches without necessarily knowing which is most effective. For example, National Museums Liverpool⁴ deliver their flagship dementia project “House of Memories” via a digital app, whereas other museums focus more on tactile experiences. As Camic⁵ states, citing Rowlands (2008) and Critchley (2008), the sense of touch is increasingly important as other senses fail during the ageing process, and neuropsychological evidence suggests a

strong link between touch and feelings of well-being. Furthermore, research has shown the importance of new experiences and investigations to help those with early and middle stage dementia in helping to slow the development of the disease (de Medeiros & Basting, 2014). Camic, Kimmel, and Hulbert (2017) also discuss evidence (Paddon, Thomson, Lanceley, Menon, & Chatterjee, 2013) that the multisensory experience of handling museum objects necessitates a deeper level of processing, helping to consolidate new information. Both the well-being and cognitive benefits of object handling versus other forms of interpretation thus merit further investigation.

Context: Memory studies and material culture

Hooper-Greenhill (1992) has argued that Europe's first museums grew from a much longer tradition of creating visual mental maps in order to store and retrieve knowledge. Visitors to 17th century cabinets of curiosities were encouraged to handle and explore objects with all their senses (Candlin, 2008; Classen, 2012), suggesting that tactile and sensory experiences were important for encoding and subsequently recalling information. Even where museums discourage physical touch, it is possible to invoke a sensory experience through powerful language and description. Lindhé (in Van Den Akker & Legêne, 2016) argues that the ancient Greek rhetorical technique of "ekphrasis" conjured such vivid images in the listener's mind that the effect was almost physical, stirring the emotions, and providing a sense of "being there." Contemporary exhibition design uses both ekphrasis and "mental mapping" to create a memorable experience. "Star objects" are often placed in prominent positions within galleries, or framed by the museum architecture and dramatically lit, whilst physical features and the "charisma" of objects may, in themselves, provoke an emotional response from visitors (Wingfield, 2010)⁶. Arguably, then, today's museums direct visitors from one key object to the next, enabling them to construct a mental map of their route, reinforced by sensory and emotional responses to the objects they encounter along the way. This recalls the decision to construct early Christian churches along existing routes and popular gathering points to enable a fluid process of conversion to the new religion in the Late Antique period (Sweetman, 2015). The creation, memorizing, and retelling of stories have been fundamental to human society in the past and present, helping solidify a shared sense of identity. Stories, like memories, are not linear, although once put within a historical context or even uni-sensory context, they become so. While museums have consciously tried to be explicit in their display policies in creating ideas about how identity works, rather than the ideal of identity (Filene, 2017), the use of a single sense (primarily sight) in the museum context means that the curator's choice of display is further sanitized by the uni-sensory experience. Hamilakis (2013, p. 3) notes the particularly impactful experience of war through museums which cannot even begin to reimagine the horror created by the full sensory experience of the sounds, sights, and smells of death and violence.

Archeology is a fundamental tool by which to study memory and senses due to the inherent materiality and temporality in approach and understanding of mnemonic experiences (Pellini, 2018, p. 120). To illustrate, the situation of the Late Antique church of Epidavros, at the edge of the existing polytheistic healing sanctuary of Asklepius, was a deliberate move to draw on the memory traces of the activities and place of the earlier

cult site. Memory of the old is triggered and then connected to the new experience through actions and visual prompts such as maintaining the same processional route to the church as the earlier sanctuary and by drawing on familiar artistic scenes within the church itself. Memories of the experience within the church were intensified through for example, the use of darkened spaces, interrupted views, incense to create heady smells and elements of ritual that involve only tantalizing glimpses of the ceremony (Sweetman, 2015). The value of this element of revelation is reflected in our recent experiments (Sweetman & Hadfield 2018) where participants were drawn to the sensory box to discover through touch only, the objects inside. This experience was accompanied by a sense of anticipation and created a talking point more so than the straightforward viewing experiences of the glass case or 3-D object.

The value of the multi-sensory experience in museums is one that is widely acknowledged but not always practical. Moreover, the rather haphazard approach to its provision can at times lead to confusion about what is deemed to be interactive and what is not (Morgan, 2012). Sensory experiences and memory in museums are topics that have been debated widely, primarily in theoretical terms (Johnson, Becker, Estrada, & Freeman, 2015). However, without empirical testing, the value of sensory experiences and impact on interpretation and memory of museum visitors is unknown.

In 2016, we ran a series of experiments to get empirical data on visitor interpretation of material culture as experienced through a range of different media. We created a small interactive exhibition at the Museum of the University of St Andrews (MUSA), comprising four interpretative approaches: 3-D digital reproductions on-screen (www.sketchfab.com/bridges), glass case display, “blind-touch” of replicas, and handling originals (Sweetman & Hadfield, 2018). Most of these techniques are commonly employed by museums though the 3-D digital models are more novel. In our test of 94 individuals, of different age groups, archeological experience and backgrounds, there were some clear distinctions between audiences. For example, adults were generally reluctant to use the sensory box, but when they did so, were surprised to discover how engaging and thought-provoking it was. Children, unsurprisingly, dived straight in and were excited by the element of mystery it provided. There were also generational differences regarding the on-screen digital models. Children clustered in a group around one computer and were visibly animated as they explored the models whereas for adults it was a solitary experience. Although adults appreciated the visual quality and detail of the images, they reported a sense of distance and detachment from the artifacts and many suggested that they lost their “aura” on screen. For all age and interest groups, viewing the glass case display was a quiet, contemplative experience, but it held people’s attention for the shortest period of time (Sweetman & Hadfield, 2018). The most popular sensory experience by far, for adults, was handling the original artifacts which enabled them to see and feel details simultaneously. This generated a great deal of discussion between participants as to the object’s form, function, and meaning. Many participants also spoke of their sense of connection with the people who originally made and used the objects and, the experience of touch, sparked imaginative thinking.

Overall, our results showed that the most enhanced understanding of material culture came through using a variety of sensory experiences in conjunction with each other (blind touch, sight, handling the real object, manipulating a digital object) (Sweetman &

Hadfield, 2018). There was a tendency to focus upon the esthetic value of objects displayed visually in the case and on-screen whereas physical handling encouraged participants to consider the weight, texture, and function of the object. Thus, each form of presentation offered different insights into the history of the object, and visitor interest grew with each experience. (Sweetman & Hadfield, 2018).

Research context: Sensory experiences, memory, and the museum

The results of our earlier experiments highlighted the importance of sensory experiences in museum contexts for visitor engagement and understanding (Sweetman & Hadfield, 2018). However, it was still unclear to us how impactful these experiences were on memory formation and recall.

Existing visitor research has provided important insights into the relationship between memories, personal identity, and visitor motivations (e.g. Falk, 2009) and defining which elements of a museum visit are most memorable and why (Bitgood, Patterson, Benefield, & Landers, 1986, McManus, 1993; Bitgood & Cleghorn, 1994; Anderson et al., 2002). However, many of these studies were based on qualitative methods such as interviews, and open-ended surveys, and some used very small samples. In contrast, we developed a methodology for our experimental research with a much higher level of control over both the object stimuli and viewing conditions in order to define more clearly how presentation of museum objects affects memory, in terms of both factual recall and object recognition. Although experimental techniques such as eye-tracking have been used previously to examine visitor interactions with art and artifacts (Saunderson, Cruickshank, & McSorley, 2010), psychologists generally conduct studies in laboratory environments. Our experiments, however, took place within the University's Archeology Room where the collection is displayed in a series of wall cabinets. Participants could move between viewing stations, and importantly, interact with physical objects, much as they would in a larger museum. Numerous visitor studies have shown that people form particularly vivid and enduring memories of museum experiences (Falk, 2009). For example, John Falk and Lynn Dierking found that adults interviewed about school trips to museums consistently described their visits in great detail, and even after twenty years, their memories showed little sign of deterioration when compared to the test groups who had visited museums more recently (Falk, 2009).

Looking purely at children's recollections of museum visits, other researchers have noted the sheer diversity and idiosyncrasy of their memories, which cover (what might seem to adults) tangential details such as "the bus ride," "the big lift," and "the smelly fridge" as well as specific exhibits (Anderson et al., 2002). When the children in Anderson et al's study were asked to recall their favorite exhibit they cited many different examples, but on the whole, large-scale exhibits such as whales or dinosaurs predominated. The authors attribute this to their allure and "holding power," an effect which was magnified when the exhibits combined tactile or kinesthetic experiences (Anderson et al., 2002, p. 220). In their 2001 study Piscitelli and Anderson observed that children's drawings of visits to specific museums "showed astonishing accuracy for spatial relations, scale, shape and size" (Piscitelli & Anderson, 2001, p.278). Whilst large-scale

exhibits or features of the building were most easily recalled, there was no correlation this time with interactivity.

Although sensory and interactive aspects of the experience are clearly important in enhancing memories of the objects encountered, these studies all suggest that the object itself is prime. When U.S. company Reach Advisors collected childhood memories of 29,000 adult visitors they found that the quality of memories differed depending on whether they concerned objects or interactives. Objects tended to be described with far greater clarity than interactives and were associated with emotions or ideas that clearly chimed with the individual's personal experience. Interactives, in contrast, were remembered in vague terms as having been fun or educational (Wilkening, 2015).⁷ Where objects and artworks are used as part of therapeutic interventions for people with dementia, it seems likely that the multisensory nature of the experience triggers an emotional response which can improve both mood and confidence (Eekelaar, Camic, & Springham, 2012). For example, Mangione (2019) describes how Alan, a participant in the "Art in the Moment" program at the Art Institute of Chicago became very animated when introduced to the artwork *Untitled: Portrait of Ross in L.A.* This work, by Felix Gonzalez-Torres consists of a mountain of brightly colored candies to which visitors may help themselves. Having consumed a candy from the pile, participants added the wrapper to their own collage response to the artwork. Mangione observed that although Alan appeared tired and withdrawn, each time he ran his thumb over the wrapper he had chosen he began to smile.

Material and methods

One of the most striking observations with the first set of experiments on perceptions of material culture (Sweetman & Hadfield, 2018) was that with each sensory experience introduced, visitors became more engaged with the experience and began to consider a wider range of interpretations of the artifacts. While handling original artifacts were the most popular activity for the majority of adult participants, whether this translated into more profound memories (or not) was not assessed. (Sweetman & Hadfield, 2018).

To build on these initial results, and with a view to approaching studies of memory and material culture from a different perspective to the norm, we wanted to test whether or not there were differences in the way visitors remembered salient information about the material culture, depending on the way in which they experienced it. This meant designing an experiment which allowed direct comparison of a participant's response to three different viewing conditions, namely glass case display, virtual manipulation of 3-D models and handling of original artifacts. The effects of these viewing conditions on memory, and the potential impact on the acquisition of knowledge, falls within the domain of the study of verbalizable, *declarative memories*. Tulving (1985a) codified the distinction between two memory systems contributing to declarative memory: *episodic memory*—memory for personally-relevant events that evoke specific occurrences; and *semantic memory*—memory for facts and knowledge that is not necessarily personally relevant, but which can be generalized to a range of circumstances. Alongside this distinction, Tulving (1985b) proposed that each memory system was characterized by a different phenomenological, conscious experience. Episodic memory

was proposed to be rich in recollective experience (being able to bring to mind the *what*, *where*, and *which* of the situation being evoked), whereas semantic memory was more impoverished, but better suited to impersonal processing. Conway, Gardiner, Perfect, Anderson, and Cohen (1997) applied this to active learning settings by testing undergraduate students' memories. They found that learning in the best performing students was characterized by a shift from episodic memory, in the immediate aftermath of encoding, to semantic memory, in the months after initial testing. That is, students who went on to do well were best able to "semanticise" their richest memories, consolidating them such that they shifted from being highly idiosyncratic, to being generalizable. The key to an effective learning system is therefore one that immediately produces rich recollective experience, such that those memories might go on to be consolidated in a more generally useful way. Craik and Lockhart (1972), demonstrated that the way in which information is encountered and processed has a large effect on retrieval of episodic memory. It therefore becomes clear that measurement of the effect of material culture viewing condition on immediate memory performance has potentially important consequences for museums as places of learning. To this end, we collaborated with colleagues in the School of Psychology and Neuroscience to run a number of memory experiments.

Memory experiments

Psychologists understand the episodic memory system to be responsible for encoding (studying) and retrieving facts relating to discrete events e.g. encountering material culture exhibits within a museum. In line with Tulving's (1985b) work on the conscious experience of episodic memory, the focus of episodic memory research has broadened from studying only manipulations that affect only the *quantity* of information encoded and retrieved, to include the *quality* of the retrieval experience. This has established an understanding of recollective experience that recognizes the intertwined nature of quantitative and qualitative aspects of retrieval exemplified in the distinction between *familiarity* and *recollection* (see Yonelinas, 2002, for a review). The state of familiarity refers to the potentially ambiguous sense of having seen or experienced something before, without being able to bring to mind any confirmatory context, and is sufficient to aid the completion of recognition tasks (identifying previously encountered information from an array of information). The state of recollection is a richer experience associated with contextual information encountered during the original episode, and is necessary to complete recall tasks (bringing to mind and describing a previously encountered information with no cues to aid that description). As would be expected, recollection is not only more evocative in a qualitative sense, but also associated with the retrieval of greater quantities of information from the original encounter. Standard memory tests have shown that the greater the level of processing employed when encoding to memory—e.g. through increased engagement with the materials being studied—the more information is retrieved, and richer the recollective experience is at test (Craik & Lockhart, 1972; Gardiner, Java, & Richardson-Klavehn, 1996). The objective was therefore to establish whether the preference for handling original artifacts seen previously (Sweetman & Hadfield, 2018) corresponded to improved memory in terms of both quantitative and qualitative measures of memory retrieval.

Our experiments were therefore designed to measure the impact of Viewing Condition upon memory, using standard tests of a) Recognition, b) Recollective Experience, and c) Context Recall as measures. The rationale for using all three measures was to obtain a more nuanced understanding of the types of memories formed in each viewing condition, with a range of progressively challenging tasks. For example, Item Recognition, a quantitative measure, was anticipated to be the easiest task, whilst Context Recall, which measured the qualitative detail of memories was framed as an open-ended question and expected to be the most challenging. Recollective Experience indicated the participant's engagement of qualitatively distinct memory processes, which has ramifications for the confidence, durability, and evocative nature of memories (recollection being superior on all dimensions), but is most importantly a measure of the extent to which the participant feels they are "re-living" the experience when they remember it. A further independent variable, archaeological expertise, was also expected to improve performance, based on constructivist learning theory, our previous findings that experts draw upon their existing knowledge to investigate and make connections with new material (Sweetman & Hadfield, 2018), and a range of findings from the psychological literature (reviewed in Vicente & Wang, 1998). Finally, we categorized our objects on a number of dimensions (e.g. size, distinctive features etc) and conducted analyses at this level to see whether object properties play a role in memory independent of the experimental manipulations detailed above (that is to say, if the more striking objects are inherently more captivating than others). Our experimental methods were carefully designed to enable us to interrogate results in terms of a) Viewing Condition, b) Memory Type, c) Archeological Expertise, d) Object Type.

Methods

Participants

Participants were recruited in advance specifically for the study by means of an advertisement on the University's events page, direct email to University departments, posters around town, and an open invitation to members of the public via MUSA's community mailing list. A total of 64 adults took part. They comprised 22 undergraduate students, 25 postgraduate students and 17 people who were not students. Mean participant age was 31 years (SD 15.5 years) with a range of 18 to 80 years. The sample recruited was particularly diverse in age, compared to typical memory studies conducted in Psychology departments, largely thanks to responses to the MUSA mailing list advertisement. Before taking part in the experiment, participants answered the following question: Do you have any background in archeology (e.g. through study, fieldwork, personal interest)? 30 participants said "yes" (24 female, 6 male; mean age 29) and 34 responded "no" (29 female, 3 male, 2 non-binary; mean age 32). Responses to this question were used to allocate participants to groups ("expert"/"novice", respectively) to examine the impact of archeology experience on memory. Ethical approval for the study was obtained from the University of St Andrews Teaching and Research Ethics Committee.

Design and procedure

Participants were tested in groups ranging in size from one to three. After completing informed consent procedures, participants completed a short demographics form and

then underwent a single study phase immediately followed by a single test phase. Whilst the immediate testing of memory is somewhat unusual for an applied experiment, it represents the most accurate measure of encoding and retrieval without interference from other sources during the retention period. As such, our measurements represent the starting points from which delayed testing would show further degradation. This procedure therefore affords an important baseline measure that avoids confounds relating to individual participants' circumstances between study and test, and will be useful to any future work with an interest in areas of retention and consolidation. In the study phase, participants studied a total of 15 objects, in three different viewing conditions: 1) displayed in a glass case, viewed from a distance of approximately 1 m [Glass Case]; 2) 3-D digital models in fullscreen on a 12.3" Microsoft Surface Pro tablet, that could be rotated and zoomed using the touchscreen [Virtual Manipulation]; and 3) supervised handling of originals [Object Handling]. Participants viewed objects for 30 seconds each, in counterbalanced blocks of five [e.g. five digital models, followed by five glass case objects, followed by five handled originals]. Counterbalancing was carried out such that, across all participants, each viewing condition was equally likely to be undergone first, second, and third. This element of the design ensured that subsequent findings would be driven by the manipulations themselves rather than far less interesting order effects. During this time, participants were encouraged to examine the object and to read the associated information in three categories: 1) name; 2) date; 3) a brief description limited to one sentence (see [Figure 1](#) for example stimuli and information presented to participants). This time limit was considered ample during piloting of the experiment and is well within an average adult reading speed of 250 words per minute (Serrell, 1996) and conforms to professional expectations that visitors typically spend less than 30 seconds looking at an object. To minimize distraction, we advised participants not to speak to each other, look at objects other than those they were meant to be studying, or ask the experimenters questions during the study phase. Where participants did speak to each other or the experimenters during the experiment, we informed them that they would have the opportunity to speak about the objects and their experiences after the experiment, and instructed them to focus on the task. During the experiments the person facilitating the object handling watched how participants lifted, touched, and examined the objects and noted details such as items they seemed reluctant to handle, or features which they explored more carefully. These notes were then compiled with comments made by participants during the debrief, to provide additional contextual information. However a systematic observational study was not undertaken at this stage.

In the test phase, participants were each given a response book in which they were asked for information on the 15 objects they had encountered in the study phase and 15 objects they had not previously encountered. Previously seen and unseen objects were presented in a randomized order with no indication as to whether they had been previously encountered or not. For each tested object participants were presented with a picture and asked: (a) whether they recognized the object from the study phase (yes/no) [Item Recognition]; (b) to indicate the quality of their memory (remember/know/guess) [Recollective Experience]; (c–e) to attempt to recall the title, date, and description [Context Recall]; and (f–h) to attempt to recognize the title, date, and description from

A)



Name: Terracotta Satyr Mask

Date: Classical (475-300BC)

Description: 'This carved face may have been given as an offering in a Sanctuary of Dionysus. Dionysus was the Greek God of wine, fertility and theatre.'

B)



Name: Terracotta hand

Date: Probably Iron Age, Cypro-Archaic (750-475 BC)

Description: 'Someone suffering from a disease might place a model of the affected body part in a shrine in the hope of being cured.'

Figure 1. Examples of stimuli and information presented to participants of study.

a set of four options (for each category, the actual fields presented at study were randomly presented amidst three alternative, plausible but unpresented fields) [Context Recognition]. See [Figure 2](#) for an example set of questions from the response book. Participants were instructed not complete questions b to h if they responded “no” to the question a, and that they should not modify previously given responses, should subsequent pages in the test book give them new insight into their memories. Recall was carried out before recognition so that the recognition options would not assist recall, and the response book was printed such that recognition options were overleaf from the recall questions for the same reason. To assist with question b, the recollective experience decision, participants were given a laminated sheet to refer to throughout the test phase, providing the following definitions:

Remember: Seeing the object brings to mind something you remember thinking or doing when you encountered the object previously.

Know: The object is familiar enough that you feel confident you previously encountered it, but seeing it does not bring to mind anything relating to your previous encounter.

Guess: The object does not bring to mind any memories, nor are you confident you previously encountered it, but you have guessed that you recognise it from your previous encounter.

10.



a. Do you recognise this object? [Please mark one response option]:

☐ Yes [Answer the remaining questions on this object.]

☐ No [Skip the remaining questions on this object, and move on to the next object.]

b. Indicate the quality of your memory for this object. [Please mark one response option. If necessary, refer to the definitions on the cover page]:

☐ Remember ☐ Know ☐ Guess

c. If you remember the title on the object's label, write it below. [If you do not remember the title, please move on to question d.]

d. If you remember the date on the object's label, write it below. [If you do not remember the date, please move on to question e.]

e. If you remember the any aspect of the description on the object's label, write it below. [If you do not remember the description, please move on to question f. overleaf]:

10. continued



f. The title on the label was [If you do not remember, please guess]:

☐ Terracotta Satyr Mask

☐ Votive Offering

☐ Architectural Fragment

☐ Altarpiece Fragment

g. The date on the label was [If you do not remember, please guess]:

☐ Roman (50BC-AD400)

☐ Classical (475-300BC)

☐ Bronze Age, Middle Cypriot (2000-1650 BC)

☐ Iron Age, Archaic (750-475 BC)

h. The description on the label was [If you do not remember, please guess]:

☐ This carved face may have been given as an offering in a Sanctuary of Dionysus. Dionysus was the Greek God of wine, fertility and theatre.

☐ Faces with exaggerated features were sometimes incorporated into doorways where they would be noticed by people entering the building.

☐ This goat-like face may have been left at a sanctuary by a farmer in the hope that his livestock would prosper.

☐ This carved face, with its protruding tongue was possibly designed to intimidate those who approached the altar.

Figure 2. Example response book pages.

There was a pool of 35 objects from which we drew 15 study phase objects and 15 additional objects for the test phase. Testing took place on 13 separate days between March and November 2018, with stimulus allocation and order randomized for each testing day. Participants rotated through the viewing stations during the study phase (e.g. one participant might study objects in the order Object Handling, Glass Case, Virtual Manipulation, whilst a second might study objects in the order Virtual Manipulation, Object Handling, Glass Case), but completed the test phase simultaneously. A research assistant noted the order of viewing on the participant's test booklet. For each group of up to three participants, the entire procedure lasted 45 minutes (approximately 10 minutes for the study phase, 30 minutes for the test phase, 5 minutes for informed consent and debrief procedures).

Coding of context recall responses and statistical analyses. Responses to questions c-e were transcribed into electronic format and quantitatively scored by two raters. To score responses, a rubric was devised for each item's name, date, and information, and the raters independently scored the completeness of the responses on three- (name and date) and four- (information) point scales. Where no recall response was made, a score of 0 was automatically assigned. Agreement was high across all three categories: name 96%, date 99%, information 85%. Where the two experimenters disagreed, a third rater examined the response and the rubric and assigned a score. Scores were converted into proportions, with 0 representing entirely incomplete or incorrect context information and 1 representing entirely complete context information.

We employed parametric statistical tests to determine whether or not there were any significant differences between groups or associations between variables within our data. For the majority of our analyses, we analyzed the effects of a number of independent variables on a range of dependent variables—a design typically lending itself to factorial multivariate analysis of variance (MANOVA). However we had a relatively small sample (64) for such an analysis, and were also entering as dependent variables a series of highly correlated measurements (reducing degrees of freedom with little interpretive gain). For these reasons, we chose to conduct a single factorial analysis of variance (ANOVA) for each dependent variable. The remainder of our analyses of difference employed Student's *t*-tests and Pearson's correlations.

Results

We first examine the effects of our manipulations, age, and previous experience with archeology, on memory retrieval. We then examine the memory performance specific to the 35 objects used in our study. Throughout this presentation of results, we step through analyses of the most straightforward, quantitative measures (Item Recognition) to data that consider the more qualitative subjective experience of remembering (Recollective Experience).

In the analyses of memory retrieval, to mitigate the potential for familywise error (the elevated probability of type I error resulting from multiple comparisons) that would be present if we engaged in a series of uncorrected pairwise comparisons, we used Analysis of Variance (ANOVA). These omnibus analyses allowed us to examine main effects and interactions, which we followed with statistically conservative Bonferroni-corrected pairwise comparisons, to interrogate any significant ANOVA findings. Statistics for all ANOVAs are reported in full in [Table 1](#). In the analyses of object properties, we take a more exploratory approach, using uncorrected correlations. Given the potential inflation of type I error resulting from this approach, and the small and idiosyncratic pool of items on which we are basing our results, we are careful not to over-interpret these findings, and would suggest they be used as the basis for future, better-powered experimental work, rather than considered in their own right.

Item and context recognition

As would be expected given the small number of items studied, item recognition performance (the percentage of studied items that were recognized at test) was high. We ran a 3 (Viewing Condition: glass case [GC]; virtual manipulation [VM]; object handling [OH]) $\times$ 2 (Archeology Experience: expert; novice) mixed factorial ANOVA on these data, finding no significant differences in item recognition performance across GC (mean = 91%), VM (94%) and OH (95%) conditions, $F(2,124) = 2.25$, $p = .110$, $\eta_p^2 = .035$. We also found no differences between expert (94%) and novice (93%) item recognition, $F < 1$, and no interaction between viewing condition and archeology experience, $F < 1$. Overall, this most basic measure of memory was so straightforward that there were no differences in recognition of previously encountered objects according to how they had been viewed, or previous archeological experience.

Table 1. Summary of ANOVA statistics-dependent variable.

	Effects	Statistics	Significant
Item recognition	Viewing condition (VC)	$F(2,124) = 2.25, p = .110, \eta_p^2 = .035$	–
	Experience (E)	$F(1,62) = 0.13, p = .719, \eta_p^2 = .002$	–
	VC x E	$F(2,124) = 0.94, p = .910, \eta_p^2 = .002$	–
Context recognition	Viewing condition	$F(2,124) = 2.25, p = .110, \eta_p^2 = .035$	–
	Information (I)	$F(2,124) = 234.47, p < .001, \eta_p^2 = .791$	Y
	Experience	$F(1,62) = 0.40, p = .842, \eta_p^2 = .001$	–
	VC x I	$F(4,248) = 1.10, p = .359, \eta_p^2 = .017$	–
	VC x E	$F(2,124) = 0.56, p = .946, \eta_p^2 = .001$	–
	I x E	$F(2,124) = 1.25, p = .290, \eta_p^2 = .020$	–
	VC x I x E	$F(4,248) = 0.82, p = .516, \eta_p^2 = .013$	–
Recollective experience	Viewing condition	$F(2,124) = 5.73, p = .004, \eta_p^2 = .085$	Y
	Experience	$F(1,62) = 0.65, p = .423, \eta_p^2 = .010$	–
	VC x E	$F(2,124) = 2.20, p = .115, \eta_p^2 = .034$	–
Context recall	Viewing condition	$F(2,124) = 4.84, p = .009, \eta_p^2 = .072$	Y
	Information	$F(2,124) = 99.61, p < .001, \eta_p^2 = .616$	Y
	Experience	$F(1,62) = 5.67, p = .020, \eta_p^2 = .084$	Y
	VC x I	$F(4,248) = 2.00, p = .095, \eta_p^2 = .031$	–
	VC x E	$F(2,124) = 1.73, p = .181, \eta_p^2 = .027$	–
	I x E	$F(2,124) = 7.21, p = .001, \eta_p^2 = .104$	Y
	VC x I x E	$F(4,248) = 2.26, p = .063, \eta_p^2 = .035$	–

Note: The table lists ANOVA main effects and interactions in full for each of the four ANOVAs reported. Item recognition is the proportion of items correctly recognized as being presented at study or not (e.g. responses to Figure 2, question a). Context recognition is the proportion of context statements correctly recognized as being presented at study (e.g. responses to Figure 2, questions e, f, and g). Recollective experience is the proportion of items given Remember (R) judgments (e.g. responses to Figure 2, question b). Context recall is the proportion of correct information recalled by participants (also referred to as recall completeness, as it represents the amount of information presented to participants that they were able to completely recall; responses to Figure 2, questions c, d, and e).

We examined context recognition (the percentage of information in each category that was recognized at test) in a similar manner. We ran a 3 (Viewing Condition) x 3 (Information: name; date; description) x 2 (Archeology Experience) mixed factorial ANOVA, once again finding no significant differences in context recognition performance across GC (mean = 67%), VM (65%) and OH (67%) conditions, $F(2,124) = 2.25, p = .110, \eta_p^2 = .035$. Again, we found no differences between expert (68%) and novice (67%) item recognition, $F < 1$. The type of information being recognized did significantly influence performance, with dates (43%) significantly less well remembered than names (71%) and descriptions (88%), $F(2,124) = 234.47, p < .001, \eta_p^2 = .791$. There were no significant interactions, all F s < 1.25 . Context recognition performance showed only an effect of the type of information impacting memory, with dates less well remembered than other types of information. Across both recognition measures, we found no impact of viewing condition or archeology expertise.

We also conducted associative analyses to determine whether or not participant age was associated with item and context recognition. We ran separate Pearson's correlations to determine the association between participant age (in years) and overall recognition performance, $r(62) = .014, p = .911$, and age and context recognition, $r(62) = .021, p = .868$. Neither showed a significant relationship, suggesting that age is not associated with any decrement in memory performance, at least in these tasks.

Recollective experience and recall

We now analyze manipulations that led to the richest recollective experience—those leading to the greatest percentage of “Remember” responses. We ran a 3 (Viewing

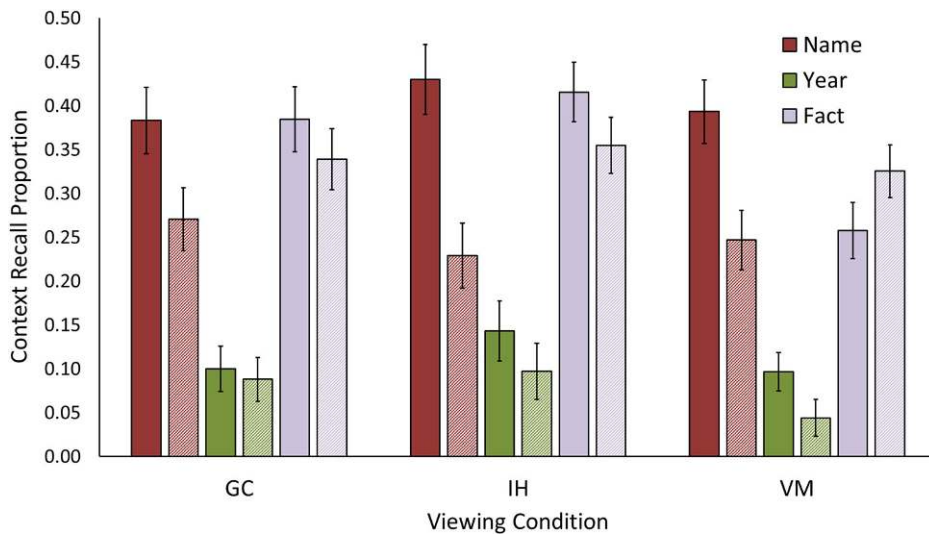


Figure 3. Context recall proportion according to viewing condition, type of information, and expertise.

Condition) $\times$ 2 (Archeology Experience) mixed factorial ANOVA and found an effect of viewing condition, such that OH (76%) led to more “Remember” responses than VM (65%) and GC (67%), $F(2,124) = 5.73$, $p = .004$, $\eta_p^2 = .085$. There were no differences between experts (72%) and novices (67%), $F < 1$, and no interactions between viewing condition and archeology experience, $F(2,124) = 2.20$, $p = .115$, $\eta_p^2 = .034$. This is the first analysis to show a difference in memory driven by viewing condition, with greatest benefit arising from object handling. Interestingly here, there were no statistical differences between glass case and virtual presentation in terms of the richness of the memories they led to, demonstrating that the increased interaction afforded by the virtual setting did not translate into a significantly richer memory for the virtually-encountered object.

If these effects of viewing condition on recollective experience are indicative of a benefit of object handling on recollection memory processes, we would expect more complete context recall to also result from object handling. We ran a 3 (Viewing Condition) $\times$ 3 (Information: name; date; description) $\times$ 2 (Archeology Experience) mixed factorial ANOVA on context recall scores, finding that the more challenging nature of this test (overall recall completeness was only 25%) made it more sensitive to differences engineered by manipulation of all three independent variables (see Figure 3). Based on the analyses presented above, the most predictable finding was the significant main effect of the type of information on recall completeness, with dates (9%) significantly less well remembered than names (33%) and descriptions (35%), $F(2,124) = 99.61$, $p < .001$, $\eta_p^2 = .616$. Consistent with the recollective experience findings, we *did* find differences in context recall according to viewing condition, $F(2,124) = 4.84$, $p = .009$, $\eta_p^2 = .072$ —some conditions did reliably lead to more information being retrieved than others. Follow-up Bonferroni-corrected pairwise comparisons (to account for the increased probability of type I error resulting from multiple comparisons) revealed that OH (28%) led to significantly a higher recall completeness than VM (23%) encoding, $p = .001$. There were no significant differences between GC

(26%) and OH or VM, all $ps > .19$. Expertise also significantly affected recall completeness, such that those with archeology experience (29%) retrieved significantly more information than those without (22%), $F(1,62) = 5.67$, $p = .020$, $\eta_p^2 = .084$. Interestingly, the main effect of expertise appears primarily driven by a specific advantage for more completely recalling the names of objects (40% vs. 25%) rather than dates (11% vs 8%) or descriptions (35% vs 34%), highlighted by the significant interaction between expertise and type of information, $F(2,124) = 7.21$, $p = .001$, $\eta_p^2 = .104$. The interactions between viewing condition and expertise, $F(2,124) = 1.73$, $p = .181$, $\eta_p^2 = .027$, type of information and viewing condition, $F(4,248) = 2.00$, $p = .095$, $\eta_p^2 = .031$, and the three-way interaction, $F(4,248) = 2.26$, $p = .063$, $\eta_p^2 = .035$, were all nonsignificant.

Bar chart showing context recall proportion (also referred to as recall completeness) (y -axis) according to viewing condition (x -axis), type of information (bar color), and expertise (bar texture). Solid bars represent participants with high expertise. Lightly shaded bars represent participants with low expertise. Error bars are standard errors of the mean.

Once again, we ran separate Pearson's correlations to determine the association between participant age and the overall proportion of "Remember" responses, $r(62) = -.099$, $p = .434$, and age and overall context recall score, $r(62) = -.131$, $p = .303$. Again, age showed no relationship with either in these tasks.

Scatterplot of recall completeness (y -axis) against recollection likelihood (x -axis) plotted for each object. The higher on the y -axis, the more objectively complete the recall information provided for that item. The further to the right on the x -axis, the greater the likelihood that the item would evoke the feeling of recollection. The color of the points represents whether the objects (i) depicted (in terms of their form or decoration) humans and/or animals (black), or (ii) were not decorated or were decorated but did not depict humans and/or animals (white).

Object analysis

Of the 35 objects used, 34 appeared frequently enough in the study phase to include in such analyses (more than five times; see Table 2). The objects were deliberately selected to represent the broad range of dates, styles, object types, functions and sizes of ceramic artifacts held in the Bridges Collection (Figures 4–7). Similarly, the object captions encompassed a range of subjects and conformed to current museum interpretation standards, e.g. by highlighting interesting features, using short sentences (max 30 words). We tested the correlation between each item's recollection likelihood and its recall completeness, to establish whether the likelihood of a richer subjective experience of memory was associated with a more complete memory. We found a significant positive relationship between these measures, such that an increased likelihood of recollection for an object was associated with an increased likelihood of recognizing it, $r(32) = .634$, $p < .001$. This relationship is illustrated in Figure 3.

We classified the objects according to a number of properties: size; object type, whether or not they incorporated any unusual features, the depiction within any decoration of the object, and the information contained within the label description. We then used these classifications to determine whether or not any properties made objects more memorable. For the most part, we observed no differences across these classifications,

Table 2. Item recognition and recollective experience properties for each object.

Item code	Object name	Study count	Recollective experience likelihood				Recall comp.
			Item recog.	Rem.	Know	Guess	
HC1994.3(48)	Model horse fragment	19	1.00	0.89	0.11	0.00	0.27
HC1994.3(15)	Sgraffito ware bowl	39	1.00	0.85	0.13	0.03	0.44
HC1994.3(144)	Seal stone	39	1.00	0.85	0.13	0.00	0.41
HC1994.3(131)	Base ring cup	18	1.00	0.83	0.11	0.06	0.36
HC2003.11	Carved stone head of a youth	17	1.00	0.82	0.12	0.00	0.24
HC1994.3(133)	Bichrome ware plate	22	1.00	0.82	0.14	0.00	0.23
HC1994.3(74)	Horse and rider figurine	24	1.00	0.79	0.17	0.04	0.23
HC1994.3(6)	Circular oil lamp	22	1.00	0.77	0.18	0.05	0.31
HC1994.3(92)	Torpedo amphora	34	1.00	0.71	0.26	0.03	0.39
HC1994.3(25)	Male figurine	20	1.00	0.70	0.20	0.10	0.24
HC1994.3(125)	Cup with wishbone handle	25	1.00	0.64	0.36	0.00	0.26
HC1994.3(135)	Black polished model horn	50	0.98	0.73	0.22	0.00	0.17
HC1994.3(26)	Terracotta bearded figurine	39	0.97	0.89	0.08	0.00	0.32
HC1994.3(138)	Terracotta satyr mask	27	0.96	0.88	0.12	0.00	0.20
HC1994.3(61)	Bearded head fragment	26	0.96	0.68	0.28	0.04	0.11
HC1994.3(45)	Terracotta hand	24	0.96	0.87	0.13	0.00	0.18
HC1994.3(31)	Horse and rider figurine	22	0.95	0.76	0.24	0.00	0.22
HC1994.3(141)	Red polished ware clay pipe	40	0.95	0.79	0.21	0.00	0.27
HC1994.3(88)	Black polished jug	18	0.94	0.65	0.35	0.00	0.13
HC1994.3(70)	Female figurine	30	0.93	0.79	0.21	0.00	0.26
HC1994.3(122)	White slip ware bowl	45	0.93	0.55	0.36	0.07	0.19
HC1994.3(137)	Red polished spindle whorl	14	0.93	0.69	0.23	0.08	0.13
HC1994.3(101)	Red polished ware jug	40	0.93	0.73	0.22	0.05	0.13
HC1994.3(68)	Figurine with phrygian cap	26	0.92	0.71	0.21	0.04	0.19
HC1994.3(90)	Red polished ware jug	37	0.92	0.74	0.15	0.06	0.16
HC1994.3(130)	Red polished ware bowl	37	0.92	0.65	0.26	0.06	0.12
HC1994.3(139)	Terracotta mask	42	0.90	0.71	0.21	0.08	0.34
HC1994.3(52)	Disk-shaped object	26	0.88	0.65	0.22	0.13	0.22
HC1994.3(110)	Black-on-red amphoriskos	25	0.84	0.38	0.52	0.10	0.17
HC1994.3(97)	Bichrome ware amphorae	27	0.81	0.73	0.18	0.09	0.27
HC1994.3(4)	Oil lamp	19	0.79	0.93	0.07	0.00	0.28
HC1994.3(1)	Terracotta baby feeder	14	0.79	0.82	0.18	0.00	0.35
HC1994.3(87)	Bichrome ware juglet	17	0.76	0.62	0.38	0.00	0.44
HC1994.3(109)	Perfume bottle	34	0.74	0.60	0.36	0.04	0.32

Note: Item code is the code by which each object is identified in the Bridges Collection Database. Study count is the number of times each object appeared in the study phase. Item recog. is the recognition likelihood when the object had been previously studied. Recollective experience likelihood is the likelihood of each of the judgements (where Rem. is “Remember”) at test. Recall comp. is the completeness of the recall responses, averaged across all types of information, at test. We have collapsed viewing condition and expertise in the presentation of this table.

but there were interesting differences observed according to the decoration depictions. We classified decorations according to whether they (i) were present and depicted humans and/or animals, or (ii) were absent or were present did not depict humans and/or animals. When comparing these two groups, we found a significantly greater likelihood of giving a “Remember” response to objects depicting humans and/or animals (77%) compared to those that did not (63%), $t(32) = 3.57$, $p = .001$, $d = 1.26$. We also observed and a trend toward greater completeness of recall for objects depicting humans and/or animals (28%) compared to those that did not (23%), $t(32) = 1.79$, $p = .083$, $d = 0.63$.

Those objects scoring highest (over 0.70) for recall likelihood included a mix of household items, figurines (Figure 4), decorated, and undecorated objects and artifacts of varied sizes. Similarly, those objects which prompted the richest memories (scoring over 0.30) for recall completeness, were also eclectic in terms of function and physical appearance, though it is interesting that they included both the oil lamps. It could be argued that the lamps are probably the most familiar archeological artifacts in the

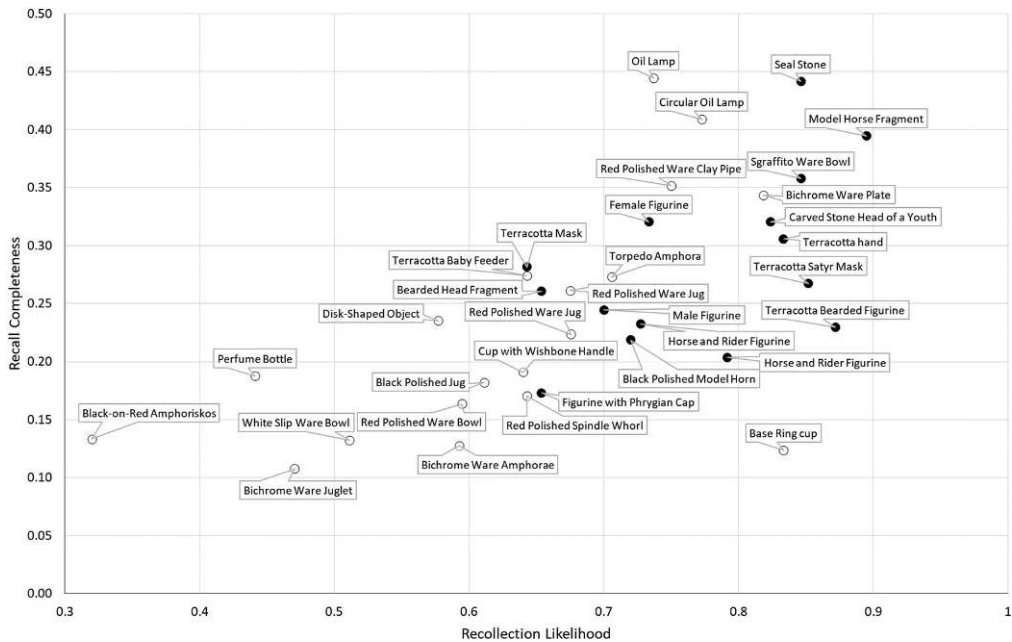


Figure 4. Recall completeness plotted against recollection likelihood.



Figure 5. Horse and Rider Figurine, HC1994.3(31). <https://skfb.ly/6ITMB>.

sample tested as they are commonly encountered in museums, popular history books and schools resources (Figure 5). As such, there may have been higher levels of prior knowledge than with other objects. However, if object familiarity was the main factor in recall completeness we would have expected significant differences according to object type, with everyday items such as bowls, plates, and cups resulting in stronger memories than more unusual objects such as the seal stone, which was not the case. In order to isolate individual features which might make certain artifacts more memorable, the artifacts were categorized by a) size, b) object type, c) presence/absence of unusual features,



Figure 6. Roman Lamp, HC1994.3(3). <https://skfb.ly/6ITJq>.

d) depiction of humans and/or animals, and e) the type of factual information provided in the object description. A brief discussion of these results follows.

(a) Size

Since visitor research elsewhere (Piscitelli & Anderson, 2001; Anderson et al., 2002) has highlighted higher recall rates for large-scale exhibits, we had anticipated that the bigger, heavier objects in the Bridges Collection, such as the torpedo amphora (Figure 6), the bichrome ware plate and the bowls might be more memorable. We categorized the objects according to whether they were small (16), medium (16) or large (2), but found no significant correlation between size and either Recollection Likelihood $r(32) = .035$, $p = .843$ or Recall Completeness $r(32) = .334$, $p = .054$ (nor did we find any significant differences when comparing the small and medium objects using t -tests). This is perhaps because the object size variation in our sample was relatively small, ranging from just 2 cm (the seal stone) to 28 cm (the torpedo amphora), so differences of scale were less noticeable to participants. The mode of experience undoubtedly also affected our results as the digital models were displayed sequentially and could be enlarged and reduced by participants at will, whereas the grouping of objects in a glass display case and handling of originals made size comparisons more obvious.

(b) Object type

For this analysis artifacts were divided into four categories according to their original context of use, i.e. household (20), church (1), theater (2), figurines (11). We found a marginally significant difference between household items and figurines in Recollection Likelihood $t(29) = 2.14$, $p = .041$, $d = 0.79$, such that household items were less likely to lead to recollection ($M = .650$, $SD = .137$) than figurines ($M = .751$, $SD = .101$). We found no significant difference in Recall Completeness, $t(29) = 0.77$, $p = .450$, $d = 0.29$.

(c) Unusual features

When using the Bridges collection for teaching, staff have observed that students often remember objects which have a surprising function or an unusual feature, e.g. the Iron



Figure 7. Torpedo Amphora, HC1994.3(92). <https://skfb.ly/6ITJs>.

Age perfume bottle bearing the thumbprint of the potter, or the small, lamp-shaped vessel which actually served as a baby feeder. It therefore seemed plausible that the element of surprise would make these objects more memorable, as well as more engaging (Sweetman & Hadfield, 2018). Artifacts were categorized as unusual either on the basis of visible physical features (e.g. the protruding tongue on the satyr mask) or label information indicating an unexpected function or aspect of the object. This comparison did not yield any differences between objects with and without unusual features, however (Recollection Likelihood: $t[32] = 1.89$, $p = .068$, $d = 0.67$; Recall Completeness: $t[32] = .94$, $p = .353$, $d = 0.33$).

(d) Depiction of humans and/or animals

For the purposes of this analysis we divided the material into two groups according to whether the objects depicted human/animal subjects or not. The object was categorized positively as representational if it took the form of a human and/or animal (e.g. a figurine) or if its surface decoration depicted a human and/or animal (e.g. the sgraffito ware bowl; Figure 7). The object was categorized negatively as nonrepresentational if it was undecorated, or its decorations did not depict humans or animals (e.g. the lamps; Figure 5). When comparing these two groups, we found a significant difference between representational objects and nonrepresentational objects in Recollection Likelihood, $t(32) = 3.57$, $p = .001$, $d = 1.26$, such that representational objects were robustly more likely to lead to recollection ($M = .770$, $SD = .131$) than nonrepresentational objects ($M = .632$, $SD = .131$). These differences are shown in Figure 3. We found no significant differences in Recall Completeness, $t(32) = 1.79$, $p = .083$, $d = 0.63$ (Figure 8).

It may be that the human/animal subject matter arouses more attention and interest than inanimate or abstract subjects, resulting in better recall. During our experiments we observed that participants paid particular attention to facial features, running their fingers over the noses of figurines or commenting afterwards on details such as the



Figure 8. Sgraffito bowl, HC1994.3(15). <https://skfb.ly/6ITML>.

horse's bridle. The same phenomenon was observed by Massaro et al. (2012) when using eye-tracking to compare regions of interest (ROIs) in 100 representational artworks, comprising 50 landscape and 50 human subjects. They found that the ROIs were significantly smaller and more concentrated on artworks featuring human figures, suggesting that they are more intrinsically interesting than other visual elements. Furthermore, the study showed that attention was directed first and foremost toward the face, no doubt because of its ability to convey emotions, character and identity.

(e) Label description

The descriptions presented on the object labels fell into several different categories, including explanations of (i) the object's function (12); (ii) production technique (6); (iii) geographical origin (3); (iv) imagery/symbolism (9); (v) personal connections (1); and (vi) its significance as archeological evidence (3). Due to the small numbers of objects in each category, we chose to look informally for patterns in memorability, but found no obvious correlations between the types of facts selected and memorability. According to the Victoria and Albert Museum's gallery text-writing guidelines, visitors prefer to make "emotional and personal associations with the object first" and "connect with the people associated with the object" (V&A, 2013, 5). This preference has also emerged from audience research at the British Museum (Morris, Hargreaves, McIntyre, 2005, 21) so we might have expected a bias toward people-centred facts, but this did not occur.

Discussion

What comes out very clearly from our research, however, is the importance of the descriptive information for memory (88% recognition success rate) versus object names (71%) and dates (43%). This is arguably because the description provides the "hook"

needed for the visitor to make the emotional and personal links to the object. The relatively poor level of memory for dates was expected, based on the subjective judgments made by participants after testing. Prior knowledge of archeology made minimal difference to recall completeness (11% experts vs 8% novices) though it did assist with the recollection of object names (40% vs 25%). Museum professionals report anecdotally that date conventions such as BC (Before Christ), BP (Before Present), BCE (Before the Common Era) and date ranges expressed as centuries can be confusing to visitors. Even the sheer scale of prehistoric time can be overwhelming or meaningless to those without a background in archeology⁸. For this reason, museums sometimes opt for chronological displays of artifacts or timeline graphics to provide historical context for the objects.

This educational approach is also supported by an area of research in psychology known as the Serial Order Effect. This is the phenomenon whereby people find it is easier to remember dates/events in the order that they occurred, because the previous items act as “context” for the currently-being-retrieved item. Crowder and Roediger’s III (1976) study found that participants were better at remembering U.S. presidents when they attempted to place them in their chronological position in history than when asked to recall them in a free order. Whilst Serial Order Effect had already been observed in memory of events (episodic memory) their work demonstrated that the phenomenon also applied to memory for facts (semantic memory). Notably, Serial Order Effect produces a characteristic bow-shaped curve with better recall for initial and final elements of a series (termed primacy and recency effects).

In terms of teaching and displaying archeology and history, it is possible that people may remember dates or a sequence of objects if they are presented within a chronological framework, and in a museum context, visitors might find the first and last objects of their visit most memorable. There is currently little in the way of museum-specific research on this question and it would present an interesting line of future study. Nonetheless it should be noted that there are drawbacks to timelines as narrative devices. Whilst they are logical and easy for visitors to follow, they create an impression of events unfolding inevitably along a single pathway to the present, rather than highlighting interconnections and multiple perspectives (Lubar, 2013). As has been widely discussed (e.g. Lucas, 2002; Renfrew & Bahn, 2008), in archeological museums this tradition also carries connotations of technological development and progress, and of flawed assumptions of evolution and cultural superiority that mask other important questions about the past, such as the inter-relationships of societies and their landscapes. The challenge for museums is therefore to provide chronological context for artifacts in ways which are both meaningful to the visitor and which fit within a range of different narratives. Provision of virtual timelines with multiple access points or themes, such as those produced by the British Museum/Google Cultural Institute⁹ and the Metropolitan Museum of Art,¹⁰ could be part of the solution.

Conclusion

Our experiments have illustrated a range of points concerning memory and recall. Having tested a range of archeological artifacts we found that items depicting animals and humans were consistently more memorable than other categories of decorated or

undecorated material, pointing to the need for people-centred displays and stories in museums. Significant memory differences relating to the size, type or unusual characteristics of objects were not observed, but the variations between objects in the Bridges Collection were arguably fairly subtle and the results might be different if zoology, science or other heritage collections were used. While dates were not at all well remembered, descriptions rather than names were. If chronologies are what are important, more context and discussion about the chronology in the description of the object should help with recall. Memory and expertise work independently to make quality memories. This is encouraging in terms of the value of the museum for all. All modalities of experience lead to good recognition performance, but subjective experience is richer, borne out in more “complete” recall when objects are handled, most likely because the senses play an intrinsic role in encoding and triggering memories. This means that if the aim of any museum is to encourage individual memory formation then more interactive experiences are a significant contribution to this. These results have helped to consolidate our initial outcomes that the provision of a range of media is likely the most important means of maximizing visitor enjoyment and understanding. Importantly, providing a range of media will also enable a more inclusive approach to visitor engagement in museums. Essentially, effects of presentation modality are seen in the “richness” of the experience and are not evident in easy tests of memory. Furthermore, our findings have potentially significant implications for the role of museums in the health and well-being of communities.

Archeological objects ‘represent the visible and touchable outer world of the memory of past societies – a cultural memory that can last thousands of years but is also relevant to recent times. As first-hand memory disappears, the objects made and used even in the recent past shape our views.’ (Black, 2011, p. 417). Our work combines a distinct range of multidisciplinary approaches to the study of memory: manipulation of memory in the past, role of museums in memory formation and empirical evidence for the impact of different experiences of material culture on ability to recall information. As museums continue to develop their social responsibility beyond the traditional delivery of history and culture, it becomes increasingly apposite to ensure means of allowing formation of individual or social memories in addition to the more easily attained collective memory. A positive step forward in this regard is the availability of different sensory experiences. This is backed up in our analysis where it was clear that all means of interaction lead to good recognition performance, but subjective experience is richer, borne out in more “complete” recall when objects are handled. This means that the clinical museum environment gives way to a more memorable experience through self-directed exploration. Falk (2009, pp. 144 and 145) cites Griffin’s research comparing two school groups who participated in a) a structured facilitated museum session and b) a self-directed visit in which pupils defined their own learning agenda. In the second scenario pupils were found to derive far greater enjoyment and learning from the experience (referred to as “free choice learning”). Furthermore, the distinctiveness of the experience creates a heightened sense of awareness and a sense of revelation, thereby increasing memory retention. While we have yet to undertake the same set of testing on children, it will be interesting to see if the pattern of heightened engagement with digital media by children translates in a similar way to more recollection of the archeology and information.

Further development

Keeping in mind the mnemonic function of the museum discussed earlier, the results of our experiments have important ramifications for the design of both museum buildings and displays. A well-designed museum should take visitors on a physical journey through time and space, punctuated with captivating objects and rich sensory experiences to assist in the encoding and subsequent retrieval of memories. Objects and artworks featuring people and animals have been shown to enhance the memorability of displays in this and other studies (e.g. Massaro et al., 2012), and it is important to choose descriptive text carefully to pique curiosity and encourage deeper looking. As we observed in our 2017 experiments, hands-on experience of material culture helps to spark discussion and can act as a catalyst for talking, discussion and listening. This is beneficial both in terms of the general social function of the museum and for more specific educational purposes such as the development of literacy programs based around material culture.¹¹ We have yet to investigate the role of individual senses such as smell, sound and taste, but further data on these experiences could allow for more holistic approaches to the development of heritage sites, e.g. through sensory gardens and refreshments themed around exhibits. As we continue to develop and extend our experiments our work will contribute to a growing body of research and practice on the role of museums in community health and well-being (Willander and Larson, 2006). As discussed earlier, museum practitioners and health workers recognize that interaction with cultural material improves mental well-being and eases symptoms of dementia (Rhoads, 2009, p. 230; de Medeiros and Basting, 2014). Some museums and galleries in the UK have carried out excellent pilot projects in this field and have produced valuable guides to programing for dementia patients and their caregivers (Tunbridge Wells Museum & Art Gallery *Dementia Tool Kit*). However, as yet, there has been little empirical research undertaken on the value of different sensory experiences available in a museum to aid in memory. To understand how best to relate this to the actual museum context, we will extend our collaboration on memory research to assess the value of different sensory engagements for helping those with early and middle stage dementia, drawing upon further expertise within St Andrews University and the town “Dementia Friendly” initiative.

Notes

1. See Heimlich et al. (2010). We would like to thank the anonymous reviewers for bringing this to our attention.
2. <https://advisor.museumsandheritage.com/features/bright-white-the-battle-of-bannockburn-and-understanding-the-potential-of-virtual-environments/>
3. E.g. ‘Scottish Football Museum Reminiscence Pilot Project for People with Dementia: A Realistic Evaluation’, https://www.researchgate.net/profile/Debbie_Tolson2/publication/228970747_Scottish_Football_Museum_Remimiscence_Pilot_Project_for_People_with_Dementia_A_Realistic_Evaluation/links/0c960534bb294cec41000000/Scottish-Football-Museum-Reminiscence-Pilot-Project-for-People-with-Dementia-A-Realistic-Evaluation.pdf
4. houseofmemories.co.uk
5. Tunbridge Wells Museum and Art Gallery Demntia Toolkit www.museumsassociation.org/download?id=1150803
6. Wingfield relates these factors to a large bronze statue of the Sultanganj Buddha in Birmingham Museum and Art Gallery, which often stops visitors in their tracks. A further example is the Viking ship museum in Oslo, which is housed in a re-purposed church. The

sense of awe of seeing the 23.2 m long Gokstad ship is heightened by the high ceilings and architecture of the original church.

7. <https://www.astc.org/astc-dimensions/beginning-to-measure-meaning-in-museum-experiences/>
8. This statement is based on anecdotal experience of MUSA staff providing educational workshops to children and adults and upon discussion with other museum educators regarding best labelling practice. This study provides the first empirical evidence of the difficulties recalling dates.
9. <https://britishmuseum.withgoogle.com/>
10. <https://www.metmuseum.org/toah/>
11. Hawke (2009) and Mielonen and Paterson (2009) discuss the importance of playful social interactions in the development of literacy skills

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References

- Aldrich, R. (2009). Colonial museums in a postcolonial Europe. *African and Black Diaspora: An International Journal*, 2(2), 137–156. doi:10.1080/17528630902981118
- Anderson, D., Piscitelli, B., Weier, K., Everett, M., & Tayler, C. (2002). Children's museum experiences: Identifying powerful mediators of learning' curator. *Curator: The Museum Journal*, 45(3), 213–231. doi:10.1111/j.2151-6952.2002.tb00057.x
- Arnold-de Simine, S. (2013). *Mediating memory in the museum*. London: Palgrave-Macmillan.
- Assmann, J., & Czaplicka, J. (1995). Collective memory and cultural identity. *New German Critique*, 65, 125–133. doi:10.2307/488538
- Bitgood, S., & Cleghorn, A. (1994). Memory of objects, labels, and other sensory impressions from a museum visit. *Visitor Behavior*, 9(2), 11–12.
- Bitgood, S., Patterson, D., Benefield, A., & Landers, A. (1986). Understanding your visitors: Ten factors that influence visitor behavior. Proceedings of the 1986 American Association of Zoological Parks and Aquariums. Minneapolis, MN: American Association of Zoological Parks and Aquariums 726–743.
- Black, G. (2011). Museums, memory and history. *Cultural and Social History*, 8(3), 415–427. doi:10.2752/147800411X13026260433275
- Camic, P. M., Kimmel, J., & Hulbert, S. (2017). Museum object handling: A health-promoting community-based activity for dementia care. *Journal of Health Psychology*, 22, 1–12. doi:10.1177/1359105316685899
- Candlin, F. (2008). Touch, and the limits of the rational museum or can matter think? *The Senses and Society*, 3(3), 277–292. doi:10.2752/174589308X331323
- Classen, C. (2012). *The deepest sense: A cultural history of touch*. Urbana: University of Illinois Press.

- Conway, M. A., Gardiner, J. M., Perfect, T. J., Anderson, S. J., & Cohen, G. M. (1997). Changes in memory awareness during learning: The acquisition of knowledge by psychology undergraduates. *Journal of Experimental Psychology: General*, 126 (4), 393–413. doi:[10.1037/0096-3445.126.4.393](https://doi.org/10.1037/0096-3445.126.4.393)
- Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: a framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 11 (6), 671–684. doi:[10.1016/S0022-5371\(72\)80001-X](https://doi.org/10.1016/S0022-5371(72)80001-X)
- Critchley, H. (2008). Emotional touch: A neuroscientific overview. In: Chatterjee H (Ed.), *Touch in museums: Policy and practice in object handling* (pp. 61–73). Oxford: Berg Publishers.
- de Medeiros, K., & Basting, A. (2014). Shall I compare thee to a dose of donepezil?: Cultural arts interventions in dementia care research. *The Gerontologist*, 54(3), 344–353. doi:[10.1093/geront/gnt055](https://doi.org/10.1093/geront/gnt055)
- Eekelaar, C., Camic, P., & Springham, N. (2012). Art galleries, episodic memory and verbal fluency in dementia: an exploratory study. *Psychology of Aesthetics Creativity and the Arts*, 6 (3), 262–272. doi:[10.1037/a0027499](https://doi.org/10.1037/a0027499)
- Falk, J. H., & Dierking, L. H. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: AltaMira Press
- Falk, J. (2009). *Identity and the museum visitor experience*. Walnut Creek, CA: Left Coast Press.
- Falk, J., & Dierking, L. (1992). *The museum experience*. Washington, DC: Whalesback Books
- Filene, B. (2017). History museums and identity: Finding “them,” “me,” and “us” in the gallery. In: P. Hamilton & J. B. Gardner (Eds.), *The Oxford handbook of public history*. Oxford, UK: Oxford University Press. Retrieved from <http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199766024.001.0001/oxfordhb-9780199766024-e-18>.
- Fivush, R., Hudson, J., & Nelson, K. (1984). Children’s long-term memory for a novel event: an exploratory study. *Merrill-Palmer Quarterly*, 30(3), 303–316.
- Gardiner, J. M., Java, R. I., & Richardson-Klavehn, A. (1996). How levels of processing really influences awareness in recognition memory. *Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale*, 50(1), 114–122. doi:[10.1037/1196-1961.50.1.114](https://doi.org/10.1037/1196-1961.50.1.114)
- Hamilakis, Y. (2013). *Archaeology and the senses. Human experience, memory and affect*. Cambridge: CUP.
- Hawke, S. (2010). Exploring Literacy through Museums. Renaissance North East. Museums for Changing Lives.
- Heimlich, J. E., Sickler, J., Yocco, V., & Storksdieck, M. (2010). *Influence of immersion on visitor learning: Maya skies research report*. Edgewater, MD: Institute for Learning Innovation. Retrieved from <https://www.informalscience.org/influence-immersion-visitor-learning-maya-skies-research-report>.
- Hooper-Greenhill, E. (1992). *Museums and the shaping of knowledge*. London: Routledge.
- Johnson, L., Becker, S. A., Estrada, V., & Freeman, A. (2015). *NMC horizon report: 2015 Museum edition*. Austin, TX: The New Media Consortium. Retrieved from <http://cdn.nmc.org/media/2015-nmc-horizon-report-museum-EN.pdf>.
- Jones, A. (2007). *Memory and material culture (topics in contemporary archaeology)*. Cambridge: Cambridge University Press.
- Levent, N. & Pascual-Leone, A. (Eds.) (2014). *The multisensory museum: Cross-disciplinary perspectives on touch, sound, smell, memory, and space*. Lanham: Rowman & Littlefield).
- Lubar, S. (2013). Timelines in exhibitions. *Curator: The Museum Journal*, 65(2), 169–188. doi:[10.1111/cura.12018](https://doi.org/10.1111/cura.12018)
- Lucas, G. (2002). *Critical approaches to fieldwork*. London: Routledge.
- Mangione, G. (2019). The art and nature of health: A study of therapeutic practice in museums. In: C. Buse, D. Martin and S. Nettleton (Eds.), *Manigone: Sociology of Health & Illness*, 40(2), pp. 283–296.
- Massaro, D., Savazzi, F., Di Dio, C., Freedberg, D., Gallese, V., Gilli, G., & Marchetti, A. (2012). When art moves the eyes: A behavioral and eye-tracking study. *PLoS One.*, 7(5), e37285. Retrieved from www.ncbi.nlm.nih.gov/pmc/articles/PMC3356266/#s2. doi:[10.1371/journal.pone.0037285](https://doi.org/10.1371/journal.pone.0037285)

- McIntyre, M. H. (2005). Big Ideas and Human Stories - Formative Evaluation: Engaging visitors with Forgotten Empire: the world of Ancient Persia. June 2005. An online version of a report prepared by MHM for the British Museum. Retrieved from www.britishmuseum.org/pdf/Room%205%20Forgotten%20Empire%20Ancient%20Persia%20Report%202005.pdf.
- McManus, P. M. (1993). Memories as indicators of the impact of museum visits. *Museum Management and Curatorship*, 12 (4), 367–380. doi:10.1080/09647779309515375
- Medved, M., & Oatley, K. (2000). Memories and scientific literacy: Remembering exhibits from a science centre. *International Journal of Science Education*, 22 (10), 1117–1132. doi:10.1080/095006900429475
- Medved, M., Cupchik, G. C., & Oatley, K. (2004). Interpretative memory of artworks. *Memory*, 12(1), 119–128.
- Mielonen, A. M., & Paterson, W. (2009). Developing literacy through play. *Journal of Inquiry & Action in Education*, 3(1), 15–46.
- Morgan, J. (2012). The multisensory museum. *Glasnik Etnografskog Instituta*, 60(1), 65–77. doi:10.2298/GEI1201065M
- Paddon, H., Thomson, L. J., Lanceley, A., Menon, U., & Chatterjee, H. J. (2013). Mixed methods evaluation of well-being benefits derived from a heritage-in-health intervention with hospital patients. *Arts & Health*, 6(1), 24–58. doi:10.1080/17533015.2013.800987
- Pellini, J. R. (2018). *Senses, affects and archaeology: Changing the heart, the mind and the pants*. Newcastle: Cambridge Scholars Publishing.
- Piscitelli, B. A., & Anderson, D. (2001). Young children's perspectives of museum settings and experiences. *Museum Management and Curatorship*, 19(3), 269–282. doi:10.1080/09647770100401903
- Renfrew, C., & Bahn, P. (2008). *Archaeology: Theories, Methods and Practice*. London: Thames & Hudson.
- Rhoads, L. (2009). Museums, meaning making and memories: The need for museum programs for people with dementia and their caregivers. *Curator: The Museum Journal*, 52(3), 229–240. doi:10.1111/j.2151-6952.2009.tb00348.x
- Roediger, H., III, & Crowder, R. (1976). A serial position effect in recall of United States presidents. *Bulletin of the Psychonomic Society*, 8(4), 275–278. Vol. doi:10.3758/BF03335138
- Rowlands, M. (2008). The aesthetics of touch among the elderly. In: H. J. Chatterjee (Ed.) *Touch in Museums: Policy and Practice in Object Handling*. Oxford: Berg Publishers, pp. 187–198.
- Saunderson, H., Cruickshank, A., & McSorley, E. (2010). In: S. Dudley (Eds.), *Museum materialities: Objects, engagements, interpretations*. London and New York: Routledge.
- Serrell, B. (1996). *Exhibit Labels: An Interpretive Approach*. Walnut Creek, CA: Altamira Press.
- Smith Bautista, S. (2013). *Museums in the digital age: Changing meanings of place, community and culture*. Lanham: Altamira Press.
- Stevens, M. (2016). Touched from a distance. The practice of affective browsing. In: C. Van den Akker & S. Legêne (Eds.), *Museums in a digital culture. How art and heritage become meaningful* (pp. 13–29). Amsterdam, the Netherlands: Amsterdam University Press.
- Stevenson, J. (1991). The long-term impact of interactive exhibits. *International Journal of Science Education*, 13 (5), 521–531. doi:10.1080/0950069910130503
- Sweetman, R. J. (2015). Memory, tradition and Christianization of the peloponnese. *American Journal of Archaeology*, 119(4), 501–531.
- Sweetman, R. J., & Hadfield, A. L. (2018). Material culture as art or artefact: The role of 3-D viewing in museums. *UMAC*, 10, 46–66.
- Tulley, A., & Lucas, A. M. (1991). Interacting with a science museum exhibit: Vicarious and direct experience and subsequent understanding. *International Journal of Science Education*, 13(5), 533–542. doi:10.1080/0950069910130504
- Tulving, E. (1985a). How many memory systems are there? *American Psychologist*, 40(4), 385–398. doi:10.1037/0003-066X.40.4.385
- Tulving, E. (1985b). Memory and consciousness. *Canadian Psychology/Psychologie Canadienne*, 26(1), 1–12. Retrieved from doi:10.1037/h0080017

- Van Den Akker, C. & S. Legêne (Eds.) (2016). *Museums in a Digital Culture. How art and heritage become meaningful*. Amsterdam, the Netherlands: Amsterdam University Press.
- Vicente, K. J., & Wang, J. H. (1998). An ecological theory of expertise effects in memory recall. *Psychological Review*, 105(1), 33–57. doi:[10.1037/0033-295X.105.1.33](https://doi.org/10.1037/0033-295X.105.1.33)
- Wilkening, S. (2015). May 26, Beginning to Measure Meaning in Museum Experiences (Blog post) Association of Science Technology Centres website. Retrieved from <https://www.astc.org/>
- Willander, J., & Larsson, M. (2006). Smell your way back to childhood: Autobiographical odor memory. *Psychonomic Bulletin & Review*, 13(2), 240–244. doi:[10.3758/BF03193837](https://doi.org/10.3758/BF03193837)
- Wilton, J. (2006). Museum and memories: Remembering the past in local and community museums. *Public History Review*, 12, 58–79. doi:[10.5130/phrj.v12i0.206](https://doi.org/10.5130/phrj.v12i0.206)
- Wingfield, C. (2010). Touching the Buddha: Encounters with a charismatic object. In: S. Dudley (Ed.), *Museum materialities: Objects, engagements, interpretations* (pp. 53–70). London: Routledge.
- Wolins, I. S., Jensen, N., & Ulzheimer, R. (1992). Children's memories of museum field trips: A qualitative study. *Journal of Museum Education*, 17(2), 17–27. doi:[10.1080/10598650.1992.11510204](https://doi.org/10.1080/10598650.1992.11510204)
- Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, 46(3), 441–517.

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