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Animacy and animate imagery improve retention in the method of loci among novice users

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Abstract
Recently, researchers have identified word animacy as a strong predictor of recall. In contrast, the method of loci is an ancient mnemonic technique which takes advantage of highly structured encoding and recall processes alongside a strong imagery component to create easily remembered "memory palaces." The present experiments examine the combined effectiveness of these techniques: Experiment 1 ($N = 154$) demonstrates that the method of loci and word animacy have additive effects, while Experiment 2 ($N = 200$) demonstrates that the additive effect of animacy is likely related to both the animate nature of words themselves and animate imagery associated with them. These results have implications for hypotheses about the proximate mechanism of animacy effects (ruling out temporal order and imagery as explanations), implications regarding the nature of animacy (as being both static and dynamic), and practical implications for memory athletes and educational settings alike: The method of loci and use of animate imagery can be taught easily, and they produce high levels of recall.

Keywords Animacy · Method of loci · Memory athletes · Adaptive memory · Imagery

The animacy of a stimulus—roughly, whether it is perceived to be living or nonliving—affects how well it is remembered on a later test, and the positive effect of animacy on memory is among the most robust of the adaptive memory literature's findings. Adaptive memory researchers predicted this advantage by considering the importance of animacy in terms of its role as an environmental pressure throughout the course our evolutionary history, and noting its prominence as a feature in other literatures, notably including the neural organization of semantic memory (Caramazza & Shelton, 1998; Gobbini et al., 2011; Sha et al., 2015), visual attention and perception (Altman et al., 2016; New et al., 2007; Pratt et al., 2010; Scholl & Gao, 2013), language (Silverstein, 1976; Yamamoto, 1999), and development (Di Giorgio et al., 2017; Opfer & Gelman, 2011).

Importantly, the animacy advantage appears to be driven by semantic factors related to animacy itself, rather than related word or structural features such as categorical recall strategies (see Nairne et al., 2017, for a recent review of the effect). One might expect animates to form a "naturally tighter" category than inanimates, for example, but VanArsdall et al. (2016) demonstrated categorical recall strategies (i.e., recalling animates together and inanimates together) can be disrupted with no change in the animacy advantage (see Gelin et al., 2017). Mental arousal, processing fluency, intentionality of learning, and concurrent processing load also do not interact with the animacy advantage (Bonin et al., 2015; Li et al., 2016; Meinhardt et al., 2018; Popp & Serra, 2018).

Presently, the only manipulations that interact with animacy advantages are imagery manipulations. For example, when Bonin et al. (2015) asked participants to imagine interacting with inanimate and animate words, recall for inanimate—but not animate—words improved. Participants were given the following instructions in their Study 4:

> I am going to present you with a list of words. For each word, I am going to ask you to imagine A SITUATION in which you are interacting with the object, animal, or

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> person to which the word refers. The situation in question can be real (refers to an object that you have already interacted with) or fictional (you have never interacted with this object, but it could happen). (Bonin et al., 2015, Study 4, p. 379)

Even still, while the size of the animacy effect was reduced by Bonin and colleagues' interactive imagery instruction, it was not eliminated. Nairne et al. (2017) have suggested these results may be due to the introduction of an animate concept into the imagined scene—the self is animate, and is interacting with the to-be-remembered word. This hypothesis seems to be supported in part by evidence that contextual information about animates appears to be preferentially remembered as well: When and where animates occur is remembered better than temporal and spatial information about inanimates (Gelin et al., 2017). Further, while imagery manipulations interact with the animacy effect, they do not appear to explain it. Indeed, a concurrent visual-spatial memory load task does not eliminate the animacy effect in recall (Gelin et al., 2019), animacy effects are found with pictures matched on visual complexity and picture names matched on imageability (Bonin et al., 2014), and animacy and imagery are shown to be independent contributors to recall (Nairne et al., 2013).

The present studies were motivated in part by a need to investigate the role of imagery in the animacy effect further, as well as an unstudied dimension—temporal order. To do so, we chose to investigate the animacy effect within a popular and historically ancient mnemonic technique which relies heavily on both the importance of imagery and temporal context: The method of loci (sometimes called the "memory palace" technique). The method of loci technique has a person rely on the visually imagined memory of a familiar place or route, typically one with multiple segments or rooms (Worthen & Hunt, 2011). Importantly for our purposes, a person using the technique proceeds to create and "place" a mental image of each to-be-remembered item along a temporally organized route through the familiar place. When the time to recall items from the list comes, the route can be mentally imagined and retraced, and the "placed" images read out. Thus, the method of loci simultaneously controls two important components of the encoding and output experiences as related to animacy: imagery and temporal order. While *categorical* output strategies do not explain the animacy effect (VanArsdall et al., 2016), it is possible the animacy effect relies in part on *temporal* output strategies. Presently, no attempts have been made to regularize output order during recall of animate words to determine whether temporally organized recall strategies disrupt animacy effects. In the current experiments, we were able to assess the contribution of temporal order to animacy effects and control for participants' mental imagery by using a method that relies strongly on both (the method of loci).

While the technique dates back as far as ancient Greece and perhaps even further (Yates, 1966), one of the earliest and most informative texts about the method of loci, *Rhetorica ad Herennium*, was written around 90 B.C.E. *Ad Herennium* is the source for the majority of surviving information about how to use it and was likely the gold-standard of mnemonics in the ancient world (Caplan & Winterbottom, 2016). Despite 2000 years, the techniques laid out in this book are still largely unchanged and continue to be used today. As world memory champion Ed Cooke has said, "This book is our bible" (Foer, 2011 p. 93). Since 1991, the World Memory Championships have organized competitive "memory sports" in which people known as "memory athletes" perform amazing feats such as memorizing the serial order of multiple decks of cards, the names and faces of random people, and very long strings of random numbers (World Memory Sports Council, 2019). The most frequently cited way to accomplish these feats is through use of the method of loci technique (Foer, 2011; Maguire et al., 2003; Roediger & Dellis, 2014); it is thus at least in practice recognized as one of the most effective mnemonic techniques available for organizing information temporally and through the use of imagery.

In one of the first experiments to compare the method of loci to a control condition, Roediger (1980) demonstrated that mnemonic techniques produced a large advantage relative to rehearsal. In particular, the method of loci was (as expected) especially useful when recalling the order of the items was important, as the method of loci's path-based strategy aids in temporal organization. In a meta-analysis, the method of loci was reported to have a Cohen's *d* of 0.80 (95% confidence interval of [0.58, 1.02]), a large effect in free recall compared to rehearsal alone (Verhaeghen et al., 1992). Additionally, memory athletes anecdotally support the use of animate concepts in particular (e.g., the use of people or animals as symbols to represent playing cards or other to-be-remembered things in their memory palaces, often as part of the "Person-Action-Object" system; see Foer, 2011, for a discussion).

In the present experiments, we used the method of loci as a way of providing participants a strategy to remember presented words that both (1) employed mental imagery and (2) offered a strategy to temporally organize to-be-remembered items. These two features allowed us to examine whether the mnemonic effects of animacy persist in a highly regularized encoding and output environment not found in current animacy research.

Experiment 1 establishes the basics: Does the animacy effect persist in a highly regularized encoding and retrieval environment, and is the size of the effect diminished compared with a less strict but still beneficial control condition such as pleasantness (which is elaborative, but does not explicitly engage imagery or temporal organization)? Nairne and Pandeirada (2008) have referred to pleasantness as a "gold standard" condition for incidental elaborative encoding in free recall, for example. Additionally, pleasantness ratings of animate words have yielded animacy effects in the past (Gelin et al., 2017, Study 2). Experiment 2 moves forward and investigates the animacy effect in the method of loci more precisely, manipulating not only whether the concept a word represents is animate, but also whether an imagery manipulation explicitly designed to enhance or reduce animacy interacts with the animacy effect.

Experiment 1

The primary goal of this experiment was to determine if the animacy effect persists in the method of loci, and if so, whether the effect is similar across the method of loci condition and the pleasantness comparison condition. Participants learned a list of words; half of the words were animate and the other half were inanimate. These words were matched along 10 memory-relevant dimensions (see Nairne et al., 2013; VanArsdall et al., 2013). In one condition, novice participants were taught to use the method of loci to memorize a list of words for a later free recall test. In an incidental learning comparison condition, subjects rated the pleasantness of each word—a task that draws attention to the unique characteristics of an item and is traditionally considered to be one of the best elaborative encoding tasks (e.g., Packman & Battig, 1978). The pleasantness condition was useful because it does not explicitly use imagery, temporal organization, or intentional learning. It therefore represented a useful comparison condition for the method of loci, which employed all three of these. Performance was assessed on an immediate free recall test.

Based on the prior work of Bonin et al. (2015) and Gelin et al. (2019), we predicted the size of the animacy effect would be smaller in the method of loci condition (but not eliminated); this would be in line with their work on the interaction between imagery and animacy. Similarly, we predicted the intentional nature of the method of loci should have minor influence on the size of the animacy effect; the effect has been demonstrated in both intentional and incidental encoding conditions (Bonin et al., 2014; Nairne et al., 2013). Finally, while no prior work has investigated the impact of temporal order on the animacy effect in recall, there is also little evidence to suggest that it should.

Method

Neither of the experiments reported in this article were formally preregistered. Materials and instructions are available in the online Supplemental Materials. All experiments received approval from the institutional review board.

Participants

One hundred and fifty-four participants (94 female, 60 male) were recruited online via a Human Intelligence Task (HIT) posted on Amazon Mechanical Turk. This sample size fits the requirements suggested previously by Simmons et al. (2011) that authors collect at least 20 observations per cell. Because our design was testing for the presence of an interaction, we aimed to significantly exceed these minimum requirements and thus ended with 77 per cell. Participants were restricted to people who were in the United States, had a 95% HIT acceptance rate, and had completed at least 1,000 HITs. Demographic information (age, gender, native language) was collected at the beginning of the study, and additional information about the workers' environment, whether they "cheated" on the task (that is, wrote down the to-be-remembered words), and computer specifications were collected in a postexperiment questionnaire. Participants were paid $1.50 to complete the task, which lasted 20–25 min.

Design

This experiment used a 2 (word: animate, inanimate) × 2 (condition: method of loci, pleasantness) mixed-participants design, with word as a within-participants factor and condition as a between participants factor.

Materials

A list of 30 words, of which 15 were animate and 15 were inanimate, were selected from Nairne et al. (2013); six additional words were added to the original 24 words to create a list of 30. The two sets of word types (animate and inanimate) were matched along 10 relevant dimensions: age of acquisition, category size, category typicality, concreteness, familiarity, imagery, written frequency, meaningfulness, number of letters, and relatedness. For a list of words used in Experiment 1, see Table S1 in the Supplemental Material.

Procedure

After workers accepted the HIT, electronically gave informed consent, and completed the demographic information, the experiment began. Participants were randomly assigned to either the method of loci condition or the pleasantness ratings condition. All participants then took a final recall test followed by a postexperiment questionnaire.

In the method of loci condition, the participants were first given basic instructions. They were told they would learn a list of words by imagining placing items along a familiar path, such as a childhood home. On a later test, they were asked to mentally retrace their steps to recall the items placed in each location. Participants were also given examples of how the method of loci could be used to remember a few practice words (e.g., "imagine that the PEACH is so large that it is blocking you from the driveway"; see Instructions for Experiment 1 in the Supplemental Material).

The to-be-remembered words were presented in a random order for each participant. After the presentation of each word, participants typed in a box labeled "Location" the location where they imagined placing the word and typed in a box labeled "Image" a brief, verbal description of their image. The task was self-paced and participants spent an average of 10.8 min in total for this task. After the final word was presented, participants were asked to recall the words by mentally walking through their house and remembering the objects they placed there. Participants were given 4 min for this task.

In the pleasantness condition, participants rated the pleasantness of each word on a 5-point scale, with 1 being "very offensive" and 5 being "very pleasant." While the instructions for the pleasantness rating task did not explicitly mention a final recall test, the description for the HIT informed participants that they would be asked to memorize a list of 30 words. The task was self-paced, and participants spent an average of 2.5 min in total for this task. After the final word was rated, participants were asked to recall as many of the words as they could in 4 min.

Results

Initial method of loci and pleasantness performance

A preliminary analysis eliminated participants who did not appear to complete the method of loci task. To do this, we developed a list of minimum requirements for inclusion based on participants' imagery and location responses. To be included, responses needed to (1) have no more than six blanks, (2) consist of more than the retyped word and, perhaps most importantly, (3) contain locations rather than unrelated memories associated with each item or free associations to the item that do not resemble anything like a path. As stated in the previous section, 16 out of 77 people (nine of whom were eliminated for leaving more than six blanks) did not meet these criteria and were replaced. Participants in the pleasantness condition were eliminated if they made the same rating for all words or left more than 6 ratings blank. This never happened. To enhance transparency, Table S2 in the Supplemental Material presents examples of exclusions.

A 2 × 2 mixed analysis of variance (ANOVA) was used (with condition as a between-participants factor and word as a within-participants factor) to analyze the reaction time. As expected, participants took longer to complete the method of loci task than to make the pleasantness ratings, *M*s = 21.6 s versus 5.1 s per word, $F(1, 152) = 118.34$, $\eta^2 = .44$, $p < .001$. Reaction times for animate and inanimate words were similar, *M*s = 13.5 s versus 13.2, $F(1, 152) = 0.27$, $\eta^2 = .00$, $p = .61$. There was no interaction, $F(1, 152) = 0.39$, $\eta^2 = .00$, $p = .53$.

Recall performance

Figure 1 shows the performance on the recall test. A 2 × 2 mixed ANOVA was used to analyze recall performance. Overall, recall was higher in the method of loci condition, *M*s = .68 versus .38, $F(1, 152) = 99.30$, $\eta^2 = .40$, $p < .001$, which demonstrated that a brief period of instructions in the method of loci was sufficient to produce great mnemonic benefits. Additionally, animate words were recalled more than inanimate words, *M*s = .60 versus .45, $F(1, 152) = 124.60$, $\eta^2 = .45$, $p < .001$. This advantage for animate words was quite robust: Out of 154 participants, 112 recalled more animate words than inanimate words, 24 recalled more inanimate than animate words, and 18 recalled the same amount of both words. However, these main effects were qualified by an interaction (as predicted) such that the animacy effect was smaller in the method of loci condition than in the pleasantness condition, $F(1, 152) = 18.89$, $p < .001$. Again, we believe this interaction is most likely due to differences in imagery between the two encoding tasks, discussed further below. The mean number of intrusions per participant was low for both groups, but overall, more intrusions occurred in the method of loci group (*M*s = 0.64 vs. 0.47).

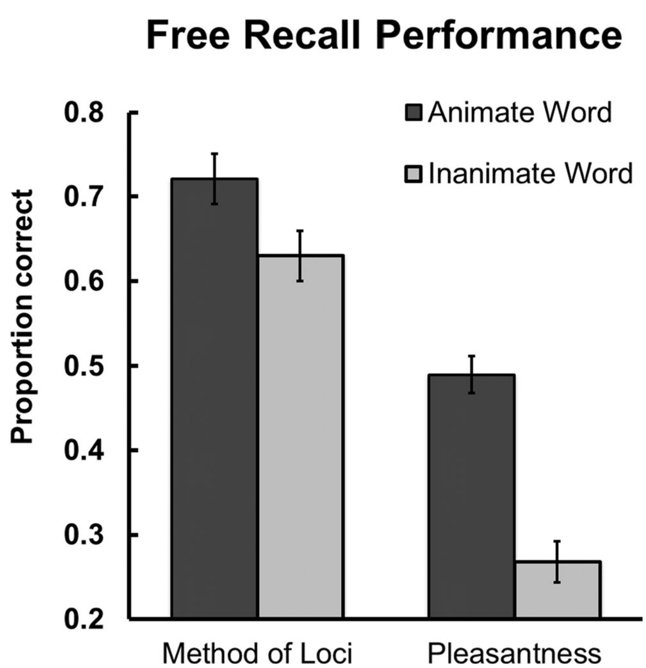

Fig. 1 Recall performance in Experiment 1. Animate words were recalled more than inanimate words, with a reduction in the size of the animacy effect in the method of loci condition. Participants in the method of loci condition recalled more than did participants in the pleasantness ratings condition. Error bars represent 95% confidence intervals

Reaction time data did not save for one participant in the method of loci condition, so the results are reported with 153 participants. Because the method of loci provided participants with an output strategy during retrieval (i.e., mentally retracing the path), it would be unsurprising if participants spent less time per word during recall in this condition. Indeed, this was the case: Participants in the method of loci condition recalled words faster than did participants in the pleasantness condition, *M*s = 12.1 s versus 9.2 s per word, $t(152) = 3.71$, $d = 0.60$, 95% CI [0.27, 0.92].

Recall output order

Of particular interest in this study, we measured whether participants relied on temporal organization to recall the words. If the method of loci provided participants with a temporal organization strategy during encoding and retrieval, then those participants would likely have a higher-than-chance measure of temporal output order and also likely have a higher temporal measure than participants in the pleasantness control condition. To measure temporal output order, we calculated input–output correspondence (Asch & Ebenholtz, 1962) and temporal factor (Polyn et al., 2009) for each participant. The Asch–Ebenholtz input–output correspondence was calculated in the following way: Imagine that a participant recalled, in order, words 1, 2, 8, 6, and 3 from the list. If neighboring words are considered as pairs, then the participant recalled four pairs (1–2, 2–8, 8–6, 6–3). In this case, two of the four pairs (1–2 and 2–8) show the correct temporally ordered sequence, resulting in an overall proportion of correctly ordered words of 0.50 (chance performance). The temporal factor described by Polyn et al. (2009) also measures output order, but it provides a more general temporal order by taking into account the temporal order of not only immediate neighboring words but also other nearby words.

Overall, participants who used the method of loci were more likely to recall the words in serial order relative to participants who made pleasantness ratings. This was true when temporal order was measured using the Asch–Ebenholtz (Asch & Ebenholtz, 1962) input output correspondence, *M*s = 0.63 versus 0.46, $t = 6.36$, $d = 1.02$, 95% CI [0.69, 1.36], and the Polyn et al. (2009) temporal factor measure, *M*s = 0.65 versus 0.57, $t = 2.57$, $d = 0.42$, 95% CI [0.09, 0.74]. This verifies that participants in the method of loci condition relied on temporal order more than did participants in the pleasantness condition, whose serial output scores were at chance levels of performance (as expected).

In addition, we also analyzed the semantic (categorical) organization of participants' recall responses. This is of particular interest because it is possible that the animacy effect occurs, at least in part, because participants notice that animate words fall under a general category of "living things." Knowing this category cue could then aid the retrieval of words in that category. If this were the case, we would expect participants to cluster their recall around things with similar semantic features in both the method of loci and pleasantness conditions. To do this, we calculated the semantic factor for each participant using "animate" and "inanimate" as semantic categories. That is, we calculated to what extent semantically related words were recalled together. As with temporal factor, a semantic factor of .50 indicates chance semantic grouping. The semantic factors for the method of loci and pleasantness conditions were $M = .53$ and .51, respectively, which indicates no semantic grouping in either condition. This is unsurprising in the method of loci condition because participants were instructed to mentally retrace their steps through their memory palace during recall and the results of the previous temporal analyses indicate that, for the most part, participants did recall in order. Additionally, both the animate and inanimate words were carefully selected to belong to a matched number of finer-grained categories (e.g., birds and furniture). The semantic factor calculated here provides additional evidence that animate objects were memorable because they were animate objects, not because of their membership in a category; these data are consistent with VanArsdall et al. (2016), which also demonstrated categorical output strategies do not explain the animacy effect through intentional disruption of participants' ability to notice commonalities in category membership.

Discussion

The results of Experiment 1 showed a strong animacy effect despite the constrained temporal structure of the method of loci and its extensive use of mental imagery. Furthermore, this benefit was not due to semantic clustering, replicating prior work (VanArsdall et al., 2016). The persistence of the animacy effect despite a constrained temporal structure finding is novel, and is the primary finding of the experiment. The experiment also conceptually replicated Bonin et al. (2015), illustrating the size of the animacy effect appears sensitive to imagery manipulations. While not the primary focus of the experiment, we were also able to illustrate the effectiveness of the method of loci mnemonic among even novice, minimally trained participants compared to incidental pleasantness ratings. While it is certainly possible participants may have engaged in more intentional study methods while simultaneously making their pleasantness ratings, (1) exploring this possibility was not the intent of the study and (2) prior work indicates (unsystematic) intentional learning in encoding environments similar to pleasantness ratings is comparable with incidental learning (e.g., Craik & Tulving, 1975; Hyde, 1973).

Experiment 2

Experiment 1 illustrated a minimum bar: Animacy effects persist in the method of loci, despite its imagery-rich environment and highly regularized structure. In Experiment 2 we took a different approach: We aimed to manipulate animacy and imagery again, but this time did so in an effort to tease out potential independent effects of what might be termed "animate imagery" and "featural animacy" (while also replicating the method of loci procedure from Experiment 1). We equate "featural animacy" with the more general notion of animacy as it has been explored by research on the animacy effect on memory—that is, the notion of whether or not a concept is living or nonliving (animacy as a semantic feature of a concept).

"Animate imagery" on the other hand, we believe is more perceptual in nature—that is, it is related to perceptual features of animacy (e.g., self-propelled movement, among other factors; see Scholl & Gao, 2013, for a review of perceptual features of animacy and intentionality). Of note, "animate imagery" is a common technique is used among memory athletes. Memory athlete Joshua Foer quotes his memory coach, Ed Cooke, who used the word "wine" as an example: "'Now, anthropomorphizing the bottles of wine is quite a good idea,' Ed suggested. 'Animate images tend to be more memorable than inanimate images. . . . Perhaps you should imagine the wines discussing their relative merits among themselves'" (Foer, 2011, p. 101).

It is therefore quite possible the animacy effect in memory is decomposable into these two complementary components: Mnemonic benefits independently related to both perceptual and semantic features of animate words. Experiment 2 was designed to replicate and extend the findings from Experiment 1, and explore this distinction between animate imagery and featural animacy. Conveniently, Experiment 2 also tested the generally accepted advice from memory athletes that animating inanimate objects produces better memory.

Method

Participants

Two hundred participants (117 female, 77 male, and six who chose to self-identify or not respond) were recruited online via a Human Intelligence Task (HIT) posted on Amazon Mechanical Turk. None of the participants in Experiment 2 had participated in Experiment 1. The mean age of the participants was 35.0 years (*SD* = 10.8, range: 19–67). The same demographic information collection, post survey questionnaire, and worker restrictions from previous experiments were used. In sum, 33 participants were excluded from the experiment for computer errors or not following directions. See Table S2 in the Supplemental Material for more information on excluded participants.

Design

A 2 (word type: animate vs. inanimate) × 2 (imagery type: animate vs. inanimate) within-participants design was used. Half of the words from the list were paired with animate imagery (e.g., "trying to escape"), and the other half were paired with inanimate imagery (e.g., "made of chocolate"). In addition, half of the words were semantically animate (e.g., "father") and half were semantically inanimate (e.g., "kite"). Therefore, there were seven words in each of the four word-imagery conditions: (a) animate–animate, (b) animate–inanimate, (c) inanimate–animate, and (d) inanimate–inanimate (see Fig. 2 for the design and an example word–image pair for each condition). Image and word pairings were counterbalanced such that each word was paired with animate imagery in one counterbalance version and inanimate imagery in another.

Materials

Twenty-eight of the 30 words used in Experiment 1 were selected for Experiment 2. This was done to create an equal number of words per condition. For a list of words and imagery used in Experiment 2, see Table S1.

Procedure

The method of loci procedure of Experiment 1 was the same in Experiment 2, with the main exception that participants were given an imagery description rather than creating one themselves. In addition, Experiment 2 instructions were slightly modified to enhance the clarity of the instructions based on feedback from participants (see Instructions for Experiment 1 in the Supplemental Material). As in Experiment 1, the method of loci task was self-paced. On

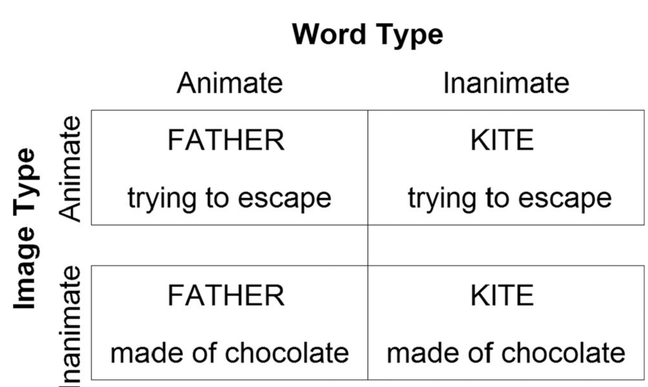

Fig. 2 Design used in Experiment 2 and example materials from each condition

average, participants spent 9.0 min in total for this task. After the method of loci task, participants were given 4 min to complete a final recall test.

Results

Initial method of loci performance

A 2 × 2 repeated-measures ANOVA was used to analyze reaction time. Participants spent a similar amount of time creating the location for animate words relative to inanimate words, *M*s = 16.3 s versus 17.4 s, $F(1, 196) = 4.03$, $\eta^2 = .02$, $p = .05$. Reaction times for animate and inanimate imagery were also similar, *M*s = 16.4 s versus 17.2 s, $F(1, 196) = 1.21$, $\eta^2 = .01$, $p = .27$. There was no interaction, $F(1, 196) = 1.10$, $\eta^2 = .01$, $p = .30$.

Final recall performance

Figure 3 shows performance on the immediate recall test. A 2 × 2 repeated-measures ANOVA was used to analyze recall performance. Overall, there was a main effect of word type, *M*s = .54 versus.48, $F(1, 199) = 21.27$, $\eta^2 = .10$, $p < .001$, and imagery type, *M*s = .52 versus.49, $F(1, 199) = 7.31$, $\eta^2 = .04$, $p = .007$, such that animate words and words paired with animate images were recalled better than inanimate words and words paired with inanimate images. There was no interaction, indicating the effect of animate images did not differ when the images were paired with animate words versus inanimate words, $F(1, 199) = 0.20$, $\eta^2 = .00$, $p = .66$.

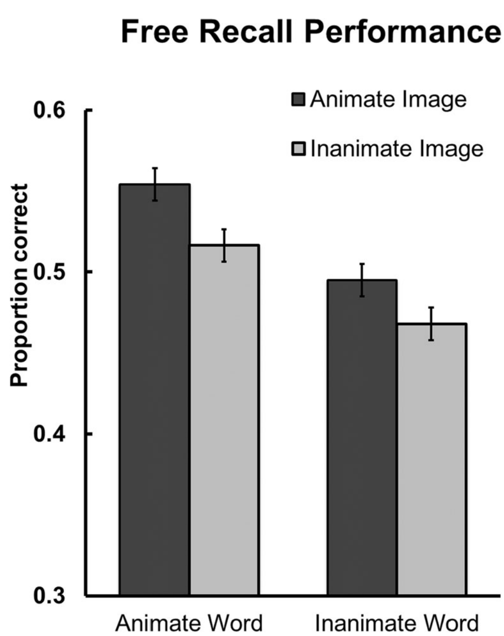

Fig. 3 Recall performance in Experiment 2. Animate words and words associated with animate images were recalled more than inanimate words and words associated with inanimate images were. Error bars represent 95% confidence intervals

Recall output order

The overall Asch and Ebenholtz (1962) input–output correspondence and Polyn et al. (2009) temporal factor in Experiment 2 were similar to Experiment 1 (Asch–Ebenholtz $M = 0.66$, Polyn $M = 0.69$), which demonstrates participants were indeed relying on some sort of temporal organization during retrieval. As in Experiment 1, the semantic factor was at chance ($M = .50$) indicating participants did not cluster their recall responses based on semantic relatedness. These data are also consistent with VanArsdall et al. (2016), who found providing too strong of an organizing semantic structure (e.g., presenting words in obvious categories) can override the animacy effect. Based on these data, providing temporal structure does not seem to impact the animacy effect as much.

Discussion

Experiment 2 replicated the animacy effect found in Experiment 1, and extended the finding by also investigating the role animate imagery plays in the animacy effect. Based on Experiment 2, it appeared featural animacy (whether a concept is a living or nonliving thing) was additive with animate imagery (as provided by us). These data are useful, as they help provide additional context for understanding the complex relationship between animacy and imagery, which has been investigated across several laboratories (e.g., Nairne et al., 2013; Bonin et al., 2015; and Gelin et al., 2019). In particular, these data suggest the animacy effect in episodic memory may actually be separable into two subcomponents, although this claim requires further validation.

General discussion

The experiments reported here provide evidence the animacy effect persists in the context of a novel, highly regularized encoding environment: the method of loci. Animate words (in both Experiments 1 and 2) were recalled better than inanimate words, and animate imagery further augments the recall of words of both types (in Experiment 2). Further, these effects were observed in the method of loci, a technique with an innate temporal order. This effectively eliminates temporal order as an explanation of the animacy effect. While the animacy effect was lessened in the method of loci compared with pleasantness in Experiment 1, it was not eliminated. Importantly, this interaction between animacy and encoding strategy was predictable given the centrality of imagery in the method of loci and prior work on animacy and imagery which indicates imagery manipulations may lessen (but do not explain) the effect (e.g., Bonin et al., 2015; Gelin et al., 2019). Additionally, measurements of output order demonstrated words were recalled (mostly) in their original order in the method of loci condition, indicating participants were using the provided temporal structure. Despite participants' use of the provided temporal structure, the animacy effect persisted.

Experiment 2 begins to tease out potential differences between animacy as a perceptual dimension and animacy as a featural dimension, in addition to replicating the basic finding from Experiment 1: Animacy effects persist in the method of loci. These results conceptually replicate VanArsdall et al. (2013), which applied animate and inanimate descriptors to nonwords and yielded an animacy effect. Experiment 2 more specifically manipulated *animate* imagery, however, whereas VanArsdall et al.'s descriptors were more conceptual in nature (e.g., "wants to be a doctor" implies animacy, but is not very imageable). While the results of Experiment 1 are similar to Bonin et al. (2015), which demonstrated imagery manipulations (of which the method of loci is one) can interact with the animacy effect, Experiment 2 diverges from this narrative: While interactive imagery instructions did not improve recall for animate words for Bonin et al., the animate imagery provided in Experiment 2 improved recall for both types of words. This is perhaps because while Bonin et al. (2015) instructed participants to imagine themselves interacting with the to-be-remembered objects, the present Experiment 2 applies imagery to the to-be-remembered objects themselves. Experiment 2 is therefore more in line with Gelin et al. (2019), which demonstrated concurrently loaded imagery tasks do not disrupt the animacy effect. Different from Gelin et al. (2019), however, the present Experiment 2 demonstrated animate imagery itself may be beneficial for recall.

The present work combined with VanArsdall et al. (2013), Bonin et al. (2015), and Gelin et al. (2019) suggest "animacy" may be separable into component dimensions: featural/conceptual (static) indicators of animacy (e.g., faces, legs, the ability to experience the world) that are largely inherent in a concept, and perceptual (dynamic) cues of animacy (e.g., self-propelled movement, intentionality, contingent behavior), which may or may not exist in any given mental image of a concept. This distinction could help explain why the animacy effect appears to be impacted (although not erased) by different kinds of imagery manipulations. Notably, animate words (which have static, semantically animate features) were still more memorable than inanimate words in Experiment 2, and adding animate imagery (that is, dynamic animacy information) also improved the memorability of animate items. While still in need of further exploration, this distinction is also well-supported outside the memory field (Opfer & Gelman, 2011).

As a side note, in comparing across the two experiments, one may notice the overall level of recall is lower in Experiment 2 compared with the method of loci condition in Experiment 1. We believe this should not be taken as evidence that the method of loci is somehow "less effective" with animate or inanimate imagery instructions, but is instead likely due to the altered nature of the task in Experiment 2. In Experiment 2, we provided participants with the image they were supposed to use for the objects in their memory palace, while these images were self-generated in Experiment 1. Previous literature has long supported the importance of self-generated cues in robust recall (Mäntylä & Nilsson, 1983; Wheeler & Gabbert, 2017), and our participants verified this anecdotally as well. One participant said, "I can remember something was writing a novel at the kitchen table, but not what exactly. Maybe it was a dove?" (It was not). Here, the participant successfully recalled the animate image ("writing a novel"), but failed to remember the rest of the image (the target word "pencil"). Indeed, this may be some anecdotal evidence for the memorability of animate images themselves.

The results of these experiments also have potential applied value, as animate imagery is additive with the method of loci. This is particularly useful because the animacy effect can be mnemonically beneficial even if items are not innately animate. That is, the benefits of animacy are not limited only to innately animate objects. An inanimate object like a nickel can be almost, if not just as, memorable as an animate object if the nickel is imagined to be crying because she is lonely. There are also potential educational benefits. Materials with sequential steps (e.g., the Krebs cycle, digestion, action potentials) or lists (e.g., Kübler-Ross stages of grief, the presidents of the USA) could be imagined using the method of loci, and each portion imagined as an animate object. The two techniques could be used in combination or on their own to best fit the needs of the material.

Finally, these experiments also provide support for memory athletes' intuitions regarding the usefulness of animacy and animate imagery in the method of loci (although the current experiments study the technique among novice users). Namely, Experiment 1 supports memory athletes' claim that the method of loci is a powerful mnemonic device (which has been well-established), and further verifies animacy is a useful addition to the technique. Experiment 2 provides promising evidence for the effectiveness of animate imagery, which was also predicted intuitively by memory athletes. Overall, the combined results of both experiments support the use of animacy to enhance the method of loci.

In conclusion, the experiments reported here demonstrate three primary findings. First, the animacy effect remains robust, even additive, when combined with one of the strongest mnemonics techniques known. Second, the temporal order innate to the method of loci effectively eliminates temporal order as an explanation for the animacy effect. Third, the use of animate imagery appears to be an effective way to simulate animacy in inanimate objects, and may constitute a separable dimension from animacy as a semantic feature of words. Finally, areas of future research should seek to continue to explore the separable contribution of animate imagery to memory, to determine the best ways to apply these findings, or to test other intuitions of memory athletes in an empirical manner.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.3758/s13421-021-01175-0.

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Declarations

Conflicts of interest We have no conflicts of interest to disclose.

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