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Remembering the Living: Episodic Memory Is Tuned to Animacy

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Abstract
Human cognition is sensitive to the distinction between living and nonliving things. Animacy plays a role in language comprehension, reasoning, the organization of knowledge, and perception. Although ignored until recently, animacy significantly influences basic memory processes as well. Recent research has indicated that people remember animate targets better than matched inanimate targets; in fact, an item's animacy status is one of the best predictors of its later recall. Animate processing of inanimate stimuli can produce retention advantages, as can animate touching—inanimate objects are remembered better when they are simply touched by animate things. We discuss these recent findings and their implications for the evolution of cognition, the methodology of memory experiments, and educational practice.

Keywords
memory, animacy, evolution, recall, adaptive

If we carve the human mind at its joints, the distinction between living and nonliving things forms a natural place to cut. Animacy is central to much of cognition, including language (Silverstein, 1976), cognitive development (Opfer & Gelman, 2011), the organization of knowledge (Caramazza & Shelton, 1998), and visual perception and attention (Pratt, Radulescu, Guo, & Abrams, 2010). From a fitness perspective, it is important to attend selectively to animate things because animates can be predators, food, mating partners, and competitors for resources. In fact, primates may possess unusually large brains relative to body size primarily because of the computational demands of agent-to-agent interactions (Dunbar, 2007).

The animate/inanimate distinction forms a skeletal principle organizing children's experiences from a very early age. Human newborns show sensitivity to the rudimentary motion cues that drive animacy perception (Di Giorgio, Lunghi, Simion, & Vallortigara, 2016), and early in the first year infants understand that animate, but not inanimate, things are capable of self-propelled movement (Markson & Spelke, 2006). By age 3 or 4, preschool children can easily distinguish between living things, such as animals, and inanimate objects; they draw richer inferences from animals as well (Heyman & Gelman, 2000). Across the world children show an affinity for animate things, and popular children's movies often assign animate properties to inanimate objects.

Perceptually, there is a "trip wire" for animacy, or at least for cues reliably associated with animacy. People readily impart animacy to inanimate objects that move in animate ways (Heider & Simmel, 1944) and to inanimate objects that move randomly so long as they have other cues that evoke animacy (e.g., the "wolfpack effect"; Gao, McCarthy, & Scholl, 2010). New, Cosmides, and Tooby (2007) proposed that the human attention system evolved to monitor and detect animates. Indeed, people can more quickly and accurately detect changes to visual scenes when the feature that changes is the presence or absence of an animate (a person or animal).

Animacy is presumably important to learning and memory as well. For example, children might find it easier to learn facts about animate things. Barrett and Broesch (2012) found a content bias for learning about dangerous animals that held for both city-dwelling children from Los Angeles and Shuar children from the Amazon region of Ecuador. Animacy-specific semantic deficits have also been found in brain-damaged patients. Some patients lose the ability to name living things, such as animals, but not nonliving entities (Caramazza & Shelton,

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1998). However, until recently, few if any studies have investigated how animacy actually affects retention in episodic memory contexts.

The Mnemonic Value of Animate Items

The failure to consider the mnemonic properties of animacy is surprising given that researchers have long recognized that item-based dimensions are important to memory. Item characteristics—such as concreteness and meaningfulness—are regularly controlled in episodic memory studies because these variables influence retention. For example, Rubin and Friendly (1986) used regression techniques to investigate item characteristics in normed free recall. They found three major predictors of what gets recalled: ease of forming a visual image, availability (the number of times the item is given as an associate in a sample of words), and emotionality. Decades of research have implicated other variables as well—age of acquisition, word length, lexical neighborhood, and so on.

Researchers sometimes use animacy judgments—that is, does the item represent a living or a nonliving thing? (e.g., Schulman, 1971)—as an orienting task in memory experiments, but the data have not been broken down by judgment. It is tough to compare animate and inanimate items directly because they potentially differ along many dimensions. To help solve this problem, we returned to Rubin and Friendly's (1986) analysis of recall norms (Nairne, VanArsdall, Pandeirada, Cogdill, & LeBreton, 2013). Animacy was not considered in their study, so we coded their words for animacy status (living vs. nonliving) and reanalyzed the data using animacy as an additional predictor variable. We discovered that animacy was one of the strongest contributors to the explainable variance. Animacy correlated strongly with recall (r = .42), and its incremental importance (the unique contribution of the variable to R^2) was nearly twice that of its nearest competitor, imagery. Simply put, animacy is an extremely important determinant of whether or not an item is recalled.

We have also investigated animacy experimentally, seeking to establish a causal link between animacy status and retention. First, we carefully matched sets of animate (e.g., "turtle") and inanimate words (e.g., "purse") along 10 mnemonically relevant dimensions (e.g., imagery, emotionality, familiarity). We then asked people to study and remember the words for a free-recall test. The animate and inanimate words were intermixed, and people were given 5 seconds to study each item. The results of the free-recall test for each of three study and test trials are shown in Figure 1. Notice that there was a strong recall advantage for the animate items on each of the test trials. Similar animacy advantages have now been reported in other labs, using different word pools, and the advantage has been found to hold for pictures of animate entities, on recognition and cued-recall tests, in between-list designs, across different encoding tasks, and when an additional memory load is required during encoding (e.g., Bonin, Gelin, & Bugaiska, 2014; Bonin, Gelin, Laroche, Méot, & Bugaiska, 2015; Gelin, Bugaiska, Méot, & Bonin, 2017; Popp & Serra, 2016).

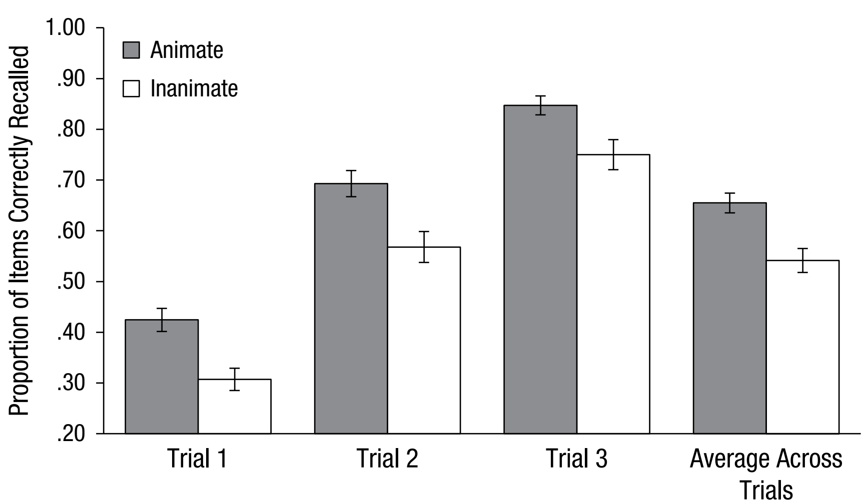

Fig. 1. Proportion of items correctly recalled on each trial as well as averaged across the three trials for matched animate and inanimate targets in Nairne, VanArsdall, Pandeirada, Cogdill, and LeBreton (2013). Error bars represent standard errors of the mean. Adapted from "Adaptive Memory: The Mnemonic Value of Animacy," by J. S. Nairne, J. E. VanArsdall, J. N. S. Pandeirada, M. Cogdill, and J. M. LeBreton, 2013, *Psychological Science, 24*, p. 2103. Copyright 2013 by the Association for Psychological Science.

We have also ruled out some relatively uninteresting interpretations of the retention advantage. For example, animate stimuli might simply come from stronger or more accessible categories than inanimate stimuli—for instance, the category "living things" might be smaller or more diagnostic than the category "inanimate objects." Researchers have long known that the organizational structure of material can significantly impact retention (e.g., Hunt & Einstein, 1981). Categorized lists are typically remembered better than lists of unrelated words because people can use the category labels as retrieval cues to help generate possible recall candidates. Perhaps people can readily rely on the category "living things" to help cue their memories for animate stimuli, especially if the "living things" category is more salient or diagnostic than the category of "nonliving things."

However, the data suggest otherwise. First, there is no evidence for categorical clustering during recall output—in other words, people tend not to recall animate items together during output, nor do they recall them especially early (Nairne et al., 2013). Moreover, if the categorical nature of the stimuli is masked during presentation by embedding a small sample of matched animate and inanimate words in a much larger list of unrelated words, the animacy advantage remains robust (VanArsdall, Nairne, Pandeirada, & Cogdill, 2017). This advantage holds as well when the animate words are drawn from tightly constrained categories ("four-footed animals" vs. "furniture"). Thus, the benefit is likely due to item-specific factors related to animacy, such as enhanced attentional monitoring.

We have also investigated the mnemonic value of *animacy processing* (VanArsdall, Nairne, Pandeirada, & Blunt, 2013). Instead of comparing the recall of animate and inanimate words, which can differ in uncontrolled ways, we asked people to process novel stimuli (nonwords) as either living or nonliving things. In these experiments, people were shown pronounceable nonword "names" (e.g., "FRAV") along with properties characteristic of either living (e.g., "enjoys cooking") or nonliving (e.g., "has a hollow center") things. For each nonword and its assigned property, the task was simply to classify the object as a living or a nonliving thing. Across participants, every nonword was processed as either a living or a nonliving thing, effectively eliminating the item itself as a controller of performance. Following the classification task, a memory test was given for the nonwords (either free recall or recognition). Once again, there was an animacy advantage: The nonwords classified as animate were recalled and recognized better than those classified as inanimate. Consequently, merely thinking about an object in an animate way may have mnemonic consequences over the long term.

These robust retention advantages reinforce the notion that our cognitive systems are tuned to detect and remember animate things. Such a tuning makes evolutionary sense because animals and people are apt to be fitness-relevant—for instance, it is much more important to remember the sudden appearance of a predator or a potential mate than it is to remember, say, a random twig blowing across the ground. If the computational demands of complex social systems helped drive the evolution of cognitive systems, we would anticipate increased processing of animate entities. Animacy forms a kind of memory-based "crib sheet" that helps us attend to and remember those things pertinent to improving the chances of survival and reproduction.

The Mnemonic Value of Animate Contact

We have found evidence for animacy-based contagion effects as well: Objects that are physically touched by animates are remembered better than objects touched by inanimate objects (Cogdill, Nairne, & Pandeirada, 2016). It is potentially adaptive to track objects that have been manipulated by agents. Touched objects can provide insight into the motivational state or intentions of the agent, which in turn may enable effective simulations of the agent's future actions. Previous research has detected a memory bias for ownership: Items that are classified as owned by an individual tend to get remembered better than neutral items (DeScioli, Rosa, & Gutchess, 2015). Moreover, the law of contagion (e.g., Rozin, Millman, & Nemeroff, 1986) suggests that objects that have been in contact may transfer some of their properties. For example, people are reluctant to interact with objects that have been touched by disgusting things (e.g., a cockroach) and are hesitant to wear clothing that has been worn by disgusting people (e.g., a serial killer). Perhaps objects that have been touched by agents acquire some mnemonic salience as well.

In our experiments, participants read sentences that described living and nonliving things interacting with inanimate objects (e.g., "the mouse is touching the sled" or "the lamp is touching the bottle"). The animate and inanimate stimuli were matched, and each inanimate object was presented, across participants, with both stimulus types. Everyone was asked to create a mental image of the action depicted and provide a corresponding vividness rating. A surprise memory test for the objects revealed significantly better memory for the objects touched by animates. Notice that in this design everyone was asked to recall exactly the same inanimate objects (e.g., sled and bottle)—what mattered was whether the inanimate object had been touched by an animate or

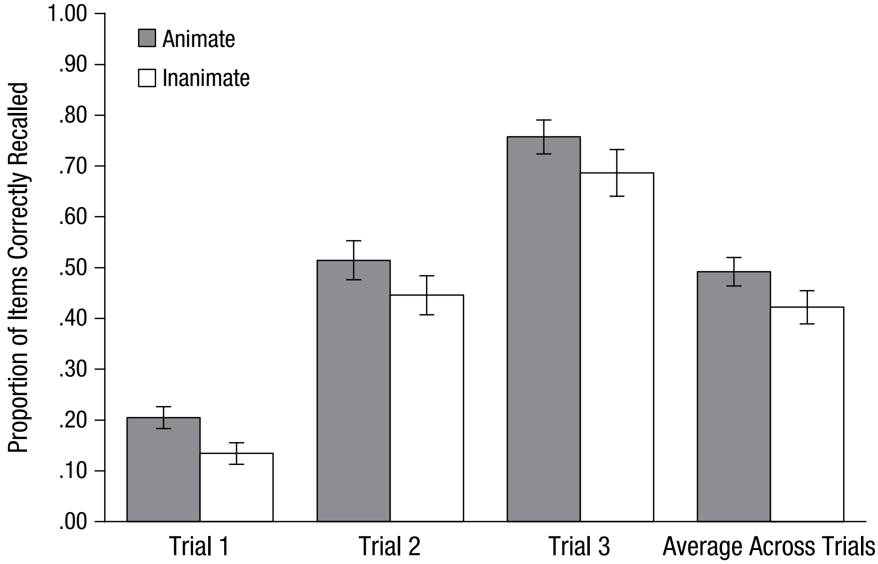

Fig. 2. Mean proportion of targets correctly recalled as a function of trial and word type (after VanArsdall, Nairne, Pandeirada, & Cogdill, 2015). Error bars represent standard errors of the mean. Reprinted from "Adaptive Memory: Animacy Effects Persist in Paired-Associate Learning," by J. E. VanArsdall, J. S. Nairne, J. N. S. Pandeirada, and M. Cogdill, 2015, *Memory, 23*, p. 660. Copyright 2015 by Taylor & Francis. Reprinted with permission.

inanimate thing. In a related study, Bonin et al. (2015) showed that the recall of inanimate objects could be boosted, relative to recall of animate objects, if people were told to imagine themselves interacting with the object. Here again, an animate being (yourself) interacting with an object improved its later retention.

An Application: Foreign-Language Vocabulary Learning

The fact that our brains may be "tuned" to learn about certain kinds of content, such as animate agents, has implications for educational practice (see Nairne, 2016). We have found that animacy can facilitate the learning of foreign-language translations (VanArsdall, Nairne, Pandeirada, & Cogdill, 2015). People were shown unfamiliar Swahili words that were assigned various English "translations." The task was to produce the appropriate English translation when given the Swahili word as a cue. We did not pair the Swahili words with their actual translations; instead, we chose translation targets that were either animate or inanimate but otherwise matched (e.g., "*rembo*"-"duck" vs. "*sahani*"-"stove"). People were told to learn the pairs such that they could produce the translation ("duck") when provided with the cue ("*rembo*"). Figure 2 shows the results for each of three test trials. Across all three trials, a strong translation advantage was found for the animate pairs.

Popp and Serra (2016) recently replicated these results, although animacy sometimes impaired cued recall in their studies. Overall, these data suggest that it is possible to exploit inherent content biases in practical learning environments. For example, it should be easier to learn a foreign language if we start with vocabulary that refers to animate agents. This logic can be extended to other fitness-relevant concepts as well. Prokop and Fančovičová (2014) recently showed that high school students find it easier to learn about botany (plants and fruits) if the to-be-learned information is framed around survival-relevant properties (e.g., ripeness or toxicity).

Summary and Future Directions

As Opfer and Gelman (2011) noted, "a creature incapable of distinguishing animates from inanimates would be severely impaired" (p. 213). Animate entities can be predators, food, mating partners, and competitors for resources, so it makes evolutionary sense for humans and other animals to develop a sensitive trip wire for the detection of animates and their corresponding behaviors. The animate/inanimate distinction has received considerable attention over the years, but only recently have its effects on memory been considered. The evidence indicates that animacy has a powerful effect on remembering. Animate items are remembered better than inanimate objects, and animacy is one of the most important predictors of long-term recall. Thus, methodologically, it behooves researchers to control for animacy status in their selection of stimulus materials.

The fact that animate items are remembered better than inanimate ones makes adaptive sense, but the proximate mechanisms that produce the benefit remain to be identified. One possibility is that animate items naturally recruit more attention, as the change-detection studies have suggested, which simply maps onto a more accessible memory trace. Another possibility is that animate items, on average, possess richer attributes or features (see Cree & McRae, 2003), which in turn makes their corresponding encodings more diagnostic during retrieval. The concept of animacy itself needs some fine-tuning as well. Although the distinction between living and nonliving things seems simple enough, a number of stimuli fall into a gray area—for instance, is a baby more "alive" than a blade of grass? Does blood count as a living thing?—what about a virus? Would we expect food and plants to be remembered well, given their survival value, or does an item's mnemonic salience depend on its similarity to a human? A robot, for instance, might be remembered well because it typically has a face and other animate features. Recent work has suggested that animacy may be a graded dimension rather than a binary one (i.e., living vs. nonliving), reflecting the extent to which an entity is capable of producing self-initiated, goal-directed movement (Sha et al., 2015). Classifications of animacy vary across languages as well, suggesting that cultural influences could also impact retention effects.

Memory researchers have historically recognized that item characteristics affect how easily an item is remembered. But the question of why our memory systems show sensitivity to these variables is often left untouched. For example, if you were building a memory system from scratch, why make it sensitive to the ease of forming a visual image? Adopting an adaptive or functional view of remembering—one that focuses on the types of problems that our memory systems help us solve—can help make sense of mnemonic sensitivities. In the case of animate stimuli, the advantages are clear. On average, animate entities are inherently more important as potential predators, prey, and social agents; it is perhaps not surprising, then, they are remembered better.

Recommended Reading

Nairne, J. S., VanArsdall, J. E., Pandeirada, J. N. S., Cogdill, M., & LeBreton, J. M. (2013). (See References). The original empirical report demonstrating animacy advantages in episodic memory.

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Scholl, B. J., & Gao, T. (2013). Perceiving animacy and intentionality: Visual processing or higher-level judgment? In M. D. Rutherford & V. A. Kuhlmeier (Eds.), *Social perception: Detection and interpretation of animacy, agency, and intention* (pp. 197–230). Cambridge, MA: MIT Press. A comprehensive, accessible overview discussing whether or not animacy is a basic property of visual perception.

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