Title

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Is a Cactus More Animate than a Wildfire? Insights from the Implicit Association Task

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Abstract

Animacy is widely thought to be conceptualized as a gradient, with humans on one end and artifacts (e.g. towel, fork) on the other. Cognitive scientists lack a clear understanding of the linguistic/conceptual organization of entities in the middle of the continuum (e.g., trees, fire, a river). Progress in this domain is constrained by over-reliance on aliveness judgments (e.g., "is a river alive?") as a way of operationalizing animacy. We present a novel method for studying animacy, an adaptation of the Implicit Association Task (IAT). While plants are judged to be alive more often than natural abiotic entities such as fire, our IAT suggests that U.S. English speakers conceptualize plants and natural abiotic entities as having similar levels of animacy. These findings highlight the need for a more comprehensive theory of how concepts of animacy are reflected in different ways across linguistic contexts.

Keywords: animacy; agency; folkbiology; concepts; semantics

Introduction

The distinction between humans and artifacts (e.g., a cup, a pen) is often described in terms of *animacy*. As an unobservable psychological construct, animacy presents researchers with a challenge. On the one hand, animacy explains a wide range of phenomena, from memory capacity to visual attention to psycholinguistic processing (Jozwik et al., 2022; Santazilia, 2022; Serra et al., 2024; Yamamoto, 1999). On the other hand, there is no one accepted definition of animacy and a range of relevant dimensions have been proposed (Félix et al., 2023; Jozwik et al., 2022; Lubbe & Castillo Alfonzo, 2024; Rissman, 2026a; VanArsdall & Blunt, 2022). In addition, researchers often draw a distinction between three types of animacy: biological (how entities are in the world), cognitive (how we think about animacy), and linguistic (how animacy is grammaticalized in morphosyntax) (Bayanati & Toivonen, 2019; Trompenaars et al., 2021). Adding to the complexity of this domain, animacy is widely thought to be conceptualized as a gradient (Lovejoy, 1936; Sha et al., 2015; Silverstein, 1976). That is, between humans and artifacts lies a range of intermediate entities, including plants, natural forces, invertebrate animals, fetuses, vehicles, and robots (Jozwik et al., 2022).

This literature on animacy intersects with research on animism, the perspective that "the world is full of persons, only some of whom are human, and that life is always lived in relationship with others" (Harvey, 2005, xi). Animist worldviews are common across cultures (Hall, 2011; Harvey, 2014; ojalehto mays et al., 2020). For example, people from a range of cultures conceptualize plants as having agency and as being able to communicate and form reciprocal relationships with other living entities (see Hall, 2011; Rissman, 2026b for review). While animacy research conducted within mainstream cognitive science has focused on the ends of the animacy continuum, researchers studying animist worldviews often focus on the intermediate range — on entities such as animals, plants, bodies of water, landscapes, and weather.

Studies on animism often juxtapose Indigenous and Western cultures (Kimmerer, 2013; ojalehto mays et al., 2020). While a range of evidence suggests that animism is relatively less prevalent among Western people (Rissman, 2026b), researchers in fact lack a clear understanding of how even English-speaking Americans attribute animacy to entities in the intermediate range. This gap in research is partially due to limitations in available methods for studying animacy. As we argue below, previous studies have over-emphasized judgments about the words *alive* and *living* as a way of operationalizing animacy. For this reason, researchers have an incomplete understanding of which aspects of animacy attribution are culturally shared and which are culturally variable. In addition, using *alive/living* to operationalize animacy assumes that the former occupy a similar part of conceptual space as the latter, but this assumption has not been rigorously tested.

The current study takes a step toward filling this gap, asking how English-speaking Americans attribute animacy to plants and natural abiotic entities. We present a new method for studying animacy, an extension of the Implicit Association Task (IAT) (Greenwald et al., 1998, 2022). Crucially, the words *alive/living* do not appear in this task. While our Animacy IAT confirms that humans are animate and artifacts inanimate, it suggests that English-speaking Americans conceptualize plants and natural abiotic entities as having similar levels of animacy, in stark contrast with how people extend the word *alive*. We also find a divergence between the Animacy IAT and an explicit rating task using the same set of words and images as the Animacy IAT. These findings raise both theoretical and methodological questions about the relationship between different tasks that are taken to reflect animacy as a construct. Perhaps most importantly, our Animacy IAT suggests more individual variation in how people attribute animacy than previous studies on aliveness judgments have shown, presenting researchers with new

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avenues for exploring how cultural, linguistic, and environmental differences influence animacy attribution.

Aliveness judgments as a window into animacy

Animacy is most often operationalized through judgments about the words *alive* and *living* (and translations of these words in other languages) (Félix et al., 2023; Lebkuecher & Malt, 2024; Rissman et al., 2019; Tremoulet & Feldman, 2006; Trompenaars et al., 2021). For example, people might be asked questions such as "is the Earth alive?" and provide *yes/no* or Likert scale judgments. *Alive* has been argued to integrate two types of knowledge (Rissman, 2026a). First, *alive* imposes a categorical distinction on the world, with an implied ground truth about which entities are alive and which are not. This categorical distinction centers around a vitalist biology, i.e. a theoretical framework in which "air, food, and water are sources of *vital energy* or *vital substance*" (Zaitchik et al., 2014). Second, *alive* integrates knowledge of conceptual gradients: on average, English-speaking adults are more likely to judge animals as alive than plants (94% vs. 78% of trials) and to judge natural abiotic entities (e.g., a river, the sun) as alive than artifacts (13% vs. 6% of trials) (Goldberg & Thompson-Schill, 2009). Rissman (2026a) found that a range of biological and agentive properties predicted variation within the living/non-living categories. For example, non-living entities that were judged to have a greater capacity for perception were more often judged as alive.

Using aliveness judgments to operationalize animacy reflects the assumption that the meanings of *alive/living* occupy a similar region of conceptual space as the concepts that are constitutive of animacy. Is this a valid assumption? On the one hand, aliveness may be the single best characterization of what the animacy construct is thought to encompass (relative to other proposed animacy dimensions such as looking like an animal, having mobility, having agency, and being unpredictable; Jozwik et al., 2022). On the other hand, researchers at least as early as Piaget (1929) have shown that the categorical biological meaning of *alive* is difficult for children to learn (see also Carey, 1985; Hatano et al., 1993; Zaitchik et al., 2014). In particular, children often report that entities such as a bicycle and the sun are alive, but not plants. This suggests that what it means to be alive in a vitalist biological sense is relatively distant from children's early understanding of animacy (see Simion et al., 2008).

Once English speakers have learned the vitalist biological meaning of *alive*, to what extent is this meaning entangled with vs. distinguishable from English speakers' conceptualization of animacy? Goldberg and Thompson-Schill (2009) found that not even biology professors are as accurate and as fast when judging the aliveness of plants vs. animals. This suggests that beyond an understanding of vitalist biology, dimensions of animacy such as goal-directed action are conceptually prominent throughout the lifespan and persist in shaping how people interpret *alive* (Opfer & Siegler, 2004). At the same time, relatively few studies have attempted to disentangle the meaning of *alive* from animacy more generally (see Jozwik et al., 2022). We present a novel method for making this comparison — one that uses language to prompt conceptualizations of animacy but avoids the specific words *alive* and *living*.

Approach: the Animacy IAT

To disentangle animacy from aliveness, we adapted the IAT for studying animacy. This task is well-used, particularly within social psychology, and is perhaps best known for its potential to reveal implicit biases that participants might be unwilling to report explicitly (e.g., biases against people of a particular race) (Greenwald et al., 1998). In general, participants in the IAT are presented with two dimensions (e.g., pictures of flowers vs. insects; pleasant vs. unpleasant words) and investigators ask which direction of aligning the dimensions is most cognitively natural for participants (e.g., flowers with pleasant words and insects with unpleasant words or the reverse). To the extent that participants are faster and more accurate with one direction of alignment than the other, this suggests more conceptual and semantic connections for the easier alignment (e.g., more connections between flowers and pleasant words than between insects and pleasant words). While the capacity of the IAT to distinguish implicit bias from explicit belief is somewhat controversial (Schimmack, 2021), and assumptions about how participants interpret the dimensions must be tested (Brendl et al., 2001), the task is widely accepted as probing which types of conceptual alignments are more or less difficult for participants.

Plants are judged to be alive much more often than natural abiotic entities are (Goldberg & Thompson-Schill, 2009; Rissman, 2026a). Is this asymmetry definitive of cognitive animacy broadly, such that it would surface across a variety of tasks, or is this asymmetry particular to the meaning of *alive*? To test this question, we adapted the IAT such that participants associated different sets of pictures (e.g., animals vs. artifacts) with animate vs. inanimate words (e.g., *lively* vs. *thing*). We compared the difference in participants' reaction times when associating one set of pictures with one set of words over the reverse mapping. For example, if plants are conceptualized as more animate than natural abiotic entities, then participants should be faster at associating plants with animate words and natural abiotic entities with inanimate words than the reverse. This task differs from aliveness judgments in that no explicit judgment is given, and that the words do not imply a ground truth (e.g., there is no ground truth about what entities are lively).

Study 1

Participants

We recruited 413 U.S. English speakers on the online crowdsourcing platform Prolific. Each person did one of the nine experiments listed in Figure 1 (43 - 48 participants per experiment). An additional 40 participants were tested but excluded because they reported not knowing one of the study

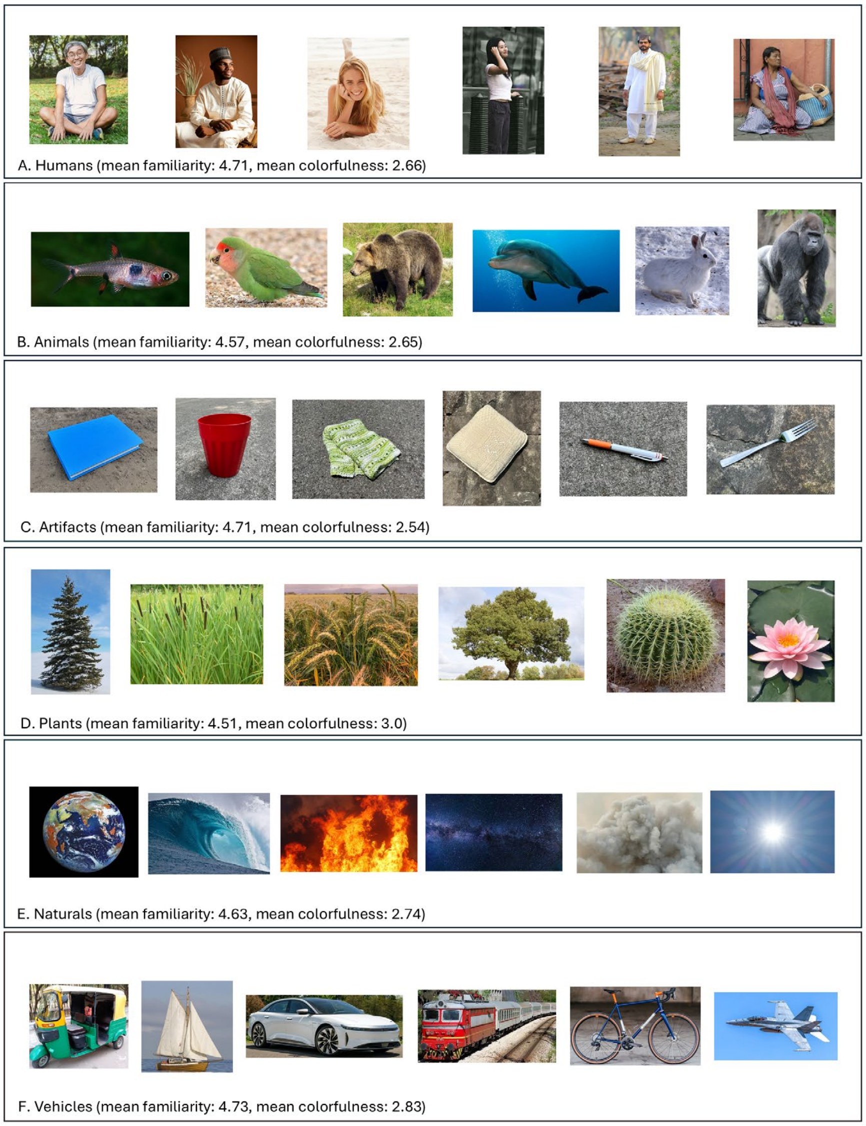

Figure 1. Images shown in Studies 1 & 2 arranged by category.

words ($N = 22$), they reported being a non-native speaker of English ($N = 4$), they displayed chance-level accuracy on the image-only blocks ($N = 11$), or their median reaction time on the final blocks of trials was less than 300 ms (i.e. they sped through the end of the task; $N = 3$). Each participant received $2.00.

Design/Materials

As described earlier, animacy is widely understood as multi-dimensional. We selected words that sampled across this conceptual space: five animate words (*aware, action, lively, moving, spirit*) and five inanimate words (*inert, object, static, still, thing*). These were chosen based on Harvey's (2005) definition of "person" and by asking 16 English speakers to list words associated with "animate", "inanimate," and "animism." The average number of letters was comparable across the animate vs. inanimate words, as was the average frequency of the words in each category. These words were selected independently from the image categories we tested. We chose six images from each of six entity categories (Humans, Animals, Plants, Natural abiotic entities, Vehicles, Artifacts). These images were previously normed for familiarity and colorfulness (Rissman, 2026a); average values on these norms were similar across the six categories (see Figure 1). We conducted nine IAT experiments — each featured a contrast between two categories of images (e.g., Humans and Artifacts; see Figure 2). The nine contrasts were chosen to assess the construct validity of the Animacy IAT, as well as probe how participants attribute animacy to plants and natural abiotic entities specifically.

Procedure

We used a standard IAT blocking procedure words (Greenwald et al., 2022). In Block 0, participants learned to map the two sets of words to different keys (e.g., pressing 'D' for animate words and 'K' for inanimate words; 40 trials). We referred to the words as 'Category 1 words' and 'Category 2 words' since *animate* and *inanimate* are not well-known words. Participants viewed a single word in each trial and had to press the correct key before moving to the next trial. In Block 1, participants learned a mapping between two sets of pictures and keys (e.g., 'D' for humans and 'K' for artifacts; 24 trials). Pictures were shown one at a time and participants were required to press the correct key. In Block 2, participants sorted words again using the same key mapping as in Block 0 (40 trials). Blocks 3-4 combined words and images: participants viewed either a single word or a single image and had to apply the mappings they had learned in the previous blocks (e.g., pressing 'D' for animate words or humans, 'K' for inanimate words or artifacts; 88 trials). In Block 5, the key mapping for images switched (e.g., 'K' for humans and 'D' for artifacts; 36 trials). Finally, in Blocks 6-7, participants viewed both words and images again, but with the new key mapping for images (88 trials). Following Greenwald et al. (2022), a particular key ('D' vs. 'K') was correct no more than four trials in a row.

For each experiment, we articulated a hypothesis about which alignment of dimensions would be conceptually easiest for participants. For example, we expected that aligning humans with animate words would be easier than aligning humans with inanimate words. Congruent blocks feature the easier mapping (e.g., 'D' for animate words or humans) while incongruent blocks feature the harder mapping (e.g., 'D' for animate words or artifacts). For each of the experiments listed in Figure 2, we hypothesized that the image category to the left of the slash (e.g., Humans/Artifacts) would be easier to align with the animate words. We counterbalanced across participants whether the first combined block was congruent or incongruent. We also counterbalanced whether Category 1 words were animate or inanimate. In the combined blocks, each word and image was shown four times. There were 312 trials in total in each experiment.

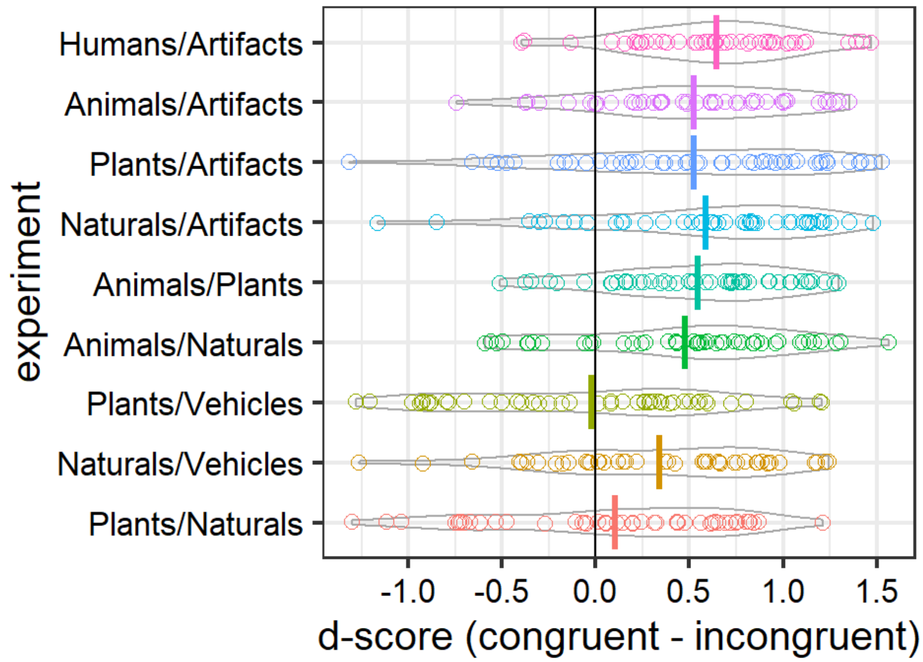

Figure 2. Mean and individual *d*-scores for each experiment (lines vs. dots). In congruent blocks, animate words are paired with the type of picture to the left of the slash in the experiment label (e.g., Humans/Artifacts).

Results and Discussion

We analyzed latency (ms) to a correct response in the combined blocks using linear mixed effects regression and the *lme4* package for R (Bates et al., 2014). While we did not analyze trials that were initially incorrect separately from correct trials, using latency to a correct response as the dependent variable instantiates a penalty for responding incorrectly, as participants must press the correct key before moving on. Trials with a latency of less than 100 ms or more than 10 seconds were excluded. Possible fixed effects in the models were stimulus type (word vs. image), congruency (trials in congruent vs. incongruent blocks), and experiment. We computed effect size *d*-scores for each participant using the *IATscores* package (see Figure 2). These scores indicate the latency difference between congruent and incongruent trials. Higher values correspond to greater speed (lower latency) in congruent over incongruent trials.

All experiments showed a congruency effect except for Plants/Vehicles. The effects for Humans/Artifacts and Animals/Artifacts support the construct validity of this task (e.g., participants were faster at associating humans with the animate words, reflecting their conceptual linkage). Analyzing just Humans/Artifacts and Animals/Artifacts, there was a significant interaction between congruency and experiment such that the congruency effect was larger in the Humans/Artifacts experiment ($b = 63.6$, $CI_{95} = [21.6, 105.7]$, $t = 2.97$, $p < .01$). This supports theories of animacy in which humans are conceptualized as more animate than animals.

Plants and natural abiotics were more animate than artifacts but less animate than animals. Interestingly, comparing Animals/Artifacts, Plants/Artifacts, and Naturals/Artifacts, there was no significant interaction between congruency and experiment. We do not interpret this to mean that English speakers attribute the same level of animacy to animals, plants, and natural abiotic entities, but rather that the artifacts have very low animacy. In other words, participants struggled to associate the pictures of artifacts with the animate words, regardless of what the artifacts were paired against. Indeed, in the Animals/Plants and Animals/Naturals experiments, there was a moderately strong congruency effect (no interaction with experiment). These results confirm that plants and natural abiotic entities have an intermediate animacy status relative to animals and artifacts.

Given the low animacy status of artifacts, we paired the plants and natural abiotic entities with vehicles, which have more animate properties than artifacts. Against a more robust competitor, we observed a congruency effect for natural abiotics but not plants. Interestingly, the *d*-scores of individual participants in these experiments were not clustered around zero, but ranged from -1.3 to 1.2. Finally, when in direct competition, plants were slightly but significantly more animate than natural abiotics (i.e., there was a congruency effect in the direction of plants; $\beta = 65.6$, $CI_{95} = [35.8, 95.4]$, $t = 4.31$, $p < .001$). Taken together, these results suggest that plants and natural abiotics are conceptualized as having similar levels of animacy. This contrasts with animacy as measured through aliveness judgments, where adults are drawing on their knowledge of vitalist biology (possessed by plants but not natural abiotic entities). This suggests that categories invoked by the animate vs. inanimate words reference different regions of conceptual space than the labels *alive/living* vs. *non-living*.

Study 2

The Animacy IAT differs from aliveness judgments on two important dimensions: presence or absence of the word *alive*, and implicit association vs. explicit judgments. To tease apart the influences of these two factors on animacy attribution to plants and natural abiotic entities, we collected explicit ratings of each of the images from Study 1 on each of the 10 animacy words. This task provides insight into whether the Animacy IAT, as an association task, reflects conceptual knowledge in a different way than more traditional semantic judgment tasks.

Participants

We recruited 81 U.S. English speakers on Prolific. An additional three participants were tested but excluded because they gave internally inconsistent ratings (e.g., artifacts being more aware than animals; N = 2) or they reported being a non-native speaker of English (N = 1). Each participant received $2.00.

Design, Materials and Procedure

Participants evaluated the images in Figure 1 on two properties chosen at random from the set of words featured in Study 1. The prompts corresponding to these 10 words are shown in Table 1. Participants provided judgments for one animate and one inanimate word (36 images presented in a random order in the first block followed by 36 images in a different random order in the second block). The study randomized whether the animate word was shown in the first or second block. For each image, participants rated on a 1-5 scale how much they agreed that the prompt was true of the entity in the picture. Prompts were worded to capture participants' understanding of stable rather than transient properties of the entities — for example, we did not want participants to rate the animals as being still just because they happened to be still in the images.

Table 1: Prompt sentences for rating task.

Word category	Prompt
Animate	This entity is lively (in general).
Animate	This entity can move.
Animate	This entity is aware.
Animate	This entity is capable of action.
Animate	This entity has a spirit.
Inanimate	This entity is inert.
Inanimate	This entity is an object.
Inanimate	This entity is a thing.
Inanimate	This entity is static (in general).
Inanimate	This entity is still (in general).

Results and Discussion

Mean ratings for each word and image category are shown in Figure 3. Unsurprisingly, humans and animals were rated as high in animacy, artifacts as low in animacy, and plants, natural abiotics, and vehicles were rated as having intermediate animacy. To quantify the relationship between categories, we calculated an animacy difference score for each category (mean rating for animate words minus mean rating for inanimate words). These values were positive for humans and animals (2.6 and 2.4, respectively) and negative for artifacts (-3.4). These values were negative for plants and vehicles (-.9 and -.5, respectively) but positive for natural abiotics (.9). For the purpose of inferential statistics, we calculated this difference score for each participant and each item (e.g., how much one participant agrees that a bear is aware minus how much they agree that a bear is a thing). Compared to a linear mixed effects baseline model with random intercepts for participant and item, picture category contributed significantly to model fit. We analyzed the significance of pairwise differences across categories using the *emmeans* package for R (Lenth & Piaskowski, 2025). The only non-significant contrasts were animals vs. humans and plants vs. vehicles. Most crucially, natural abiotic entities were rated as more animate overall than plants ($t(30) = 9.1$, $p < .001$). Further modeling shows that both sets of words contributed to this effect: plants were rated lower than naturals on the animate words ($b = -.53$, CI_{95} =[-.75, -.30], $t = -4.59$, $p < .001$) but higher than naturals on the inanimate words ($b = 1.23$, CI_{95} =[.88, 1.57], $t = 6.95$, $p < .001$)

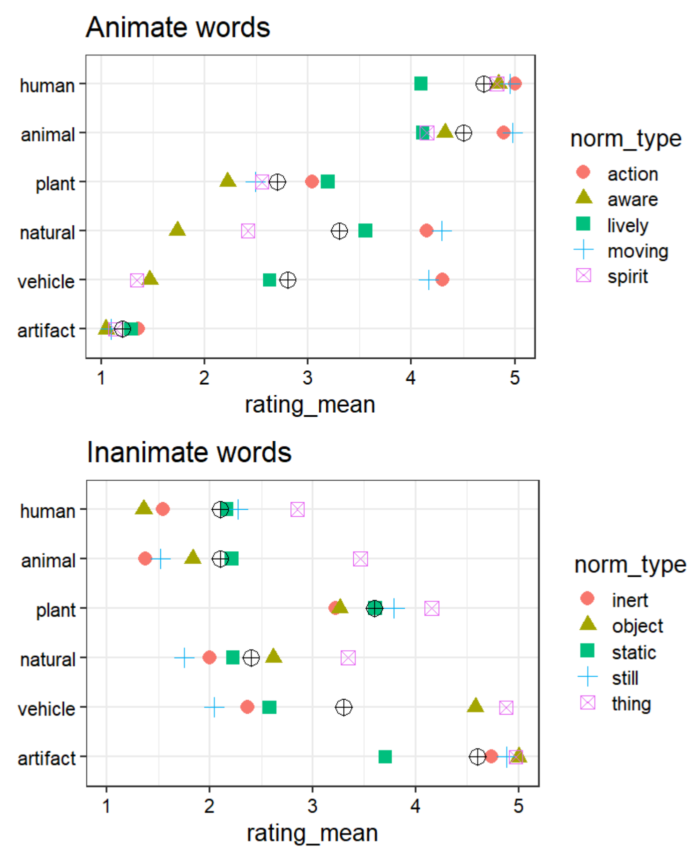

Figure 3. Mean ratings for each word and image category. Black targets indicate the mean across all five words.

These ratings show that attributing relatively low levels of animacy to plants is not merely an artifact of doing an associative task. Study 2 also suggests that performance in the Animacy IAT cannot be reduced to rating tasks for each separate word. Whereas plants were rated overall as less animate than natural abiotics in Study 2, there was a positive congruency effect for plants vs. natural abiotics in Study 1.

Discussion & conclusion

This paper demonstrates the limitations of operationalizing cognitive animacy through judgments about the meaning of *alive*. Across two tasks, we probed animacy through words that do not implicate a categorical ground truth (e.g., *lively*) and found that English-speaking Americans attribute animacy just as much to natural abiotics as to plants, if not more. This suggests that, despite English speakers' protracted learning of the dichotomous, biological meaning of *alive*, this dimension plays a relatively small role when animacy is investigated through a different set of words. One of the unique design features of the Animacy IAT is that participants are invited to formulate an abstract understanding of what binds the Category 1 vs. Category 2 words together (as these categories are not labeled). It could well have been the case that vitalist biology is so essential to animacy that this meaning was activated through the other animate words. Indeed, prior to conducting this study, one of our colleagues suggested that we label the Category 1 and Category 2 words as "living" vs. "non-living." But knowledge of vitalist biology did not appear to be strongly activated in the task. This result is consistent with Jozwik et al. (2022), who found that when English-speakers viewed images varying on multiple animacy dimensions, the aliveness dimension did not explain a significant amount of variance in patterns of neural activity. The Animacy IAT thus suggests that aliveness may be more distantly related to the overall construct of animacy than previously thought. This in turn invites a new interpretation of old data: whereas Piaget and others were surprised when a child interpreted the sun as alive, this could in fact reflect a deep-seated conceptualization of animacy that persists into adulthood, not overwritten by the vitalist biological meaning of *alive*.

Further study is needed to understand how, in the context of the IAT, each category of pictures is associated with each category of words. Finding a congruency effect does not entail that one type of picture is high in animacy and the other is low — indeed, it is not contradictory that the congruency effect for Animals vs. Plants was statistically indistinguishable from the congruency effect for Plants vs. Artifacts. Insight into the animacy of each picture category, independent of the category it is pitted against, would be gained by conducting a Single-Target IAT (Bluemke & Friese, 2008). This task features congruent vs. incongruent blocks but with only a single category of pictures (e.g. 'D' for humans or animate words; 'K' for inanimate words). In addition, global features such as familiarity can influence performance on the IAT (Brendl et al., 2001). While the images in this task were all highly familiar (see Figure 1), further study is needed to test whether incidental features of the images could have led to the observed congruency effects.

Taken together, Studies 1 and 2 demonstrate a dissociation between implicit vs. explicit ways of using the 10 target words to probe animacy. Specifically, plants were less animate than natural abiotic entities in the explicit task but not the implicit task. Additional research is needed to test possible explanations for this difference. For example, it could be that in the explicit task, participants were hesitant to affirm that large natural forces were "objects," but this association was relatively more accessible in the implicit task. It is also important to test the implicit and explicit tasks with the same set of participants. Individuals vary considerably in how they attribute animacy to plants and natural abiotic entities, as shown in Figure 2. It could be the case that in Study 2, we happened to sample individuals who attribute low levels of animacy to plants.

The current findings indeed suggest an opportunity to better understand individual differences in animacy attribution. As shown in Rissman (2026a), most English-speaking Americans utilize the dichotomous meaning of *alive* when doing a judgment task and can home in on this meaning over the course of hundreds of trials. By contrast, when participants are merely asked to associate different sets of pictures with different sets of words, there is no ground truth to calibrate toward. Figure 2 shows, for example, that some people were much faster at associating plants than vehicles with animate words, whereas other people showed the reverse pattern. Further research is needed to assess whether this individual variability is reliable across repeated testing. As described by Carpenter et al. (2023), the IAT can be a noisy measure in general, but testing each person three or four times and aggregating the results can provide an IAT difference score with greater external validity.

If the Animacy IAT is shown to be reliable and externally valid, it could be a valuable method for investigating how differences in experience (linguistic, cultural, and/or environmental) affect animacy attribution. As described earlier, people from different cultural backgrounds attribute animacy to plants and natural forces in different ways, raising important questions about the causes and consequences of this variability. Despite the importance of this issue, we are not aware of any large-scale study using a single set of methods to probe animacy attribution across a range of cultures. Methodological limitations may be one barrier to conducting such a study. If the Animacy IAT does in fact elicit more variable responses than other types of methods, it could be well suited for cross-cultural comparative research.

These lines of inquiry are important not only toward aiding in the development of better theories of animacy, but because how people think about animacy underlies numerous facets of everyday life, from interactions with AI chatbots to reactions to witnessing deforestation. Understanding how our tasks measure animacy in different ways is essential for addressing broader questions about the role of animacy in shaping our relationships with natural and artificial worlds.

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