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Thank You, Whatever You Are: Gratitude for Nonhuman Entities Through Anthropomorphism

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We propose that anthropomorphism plays a central role in producing gratitude for nonhuman entities from humans. Colloquially called personification, anthropomorphism occurs when humans attribute agency to nonhumans, enabling the latter to act upon the environment and humans alike. Humans then attribute any subsequently received benefits to a perceived intentionality of nonhumans, finding them well-intentioned and appreciable. Our five studies ($N = 2019$) support this hypothesis. First, we establish that individuals' trait anthropomorphism correlates with their experienced gratitude in recent encounters with both natural and artificial nonhumans (Study 1). Examining causality, we report that anthropomorphizing computers (Study 2), forests (Study 3), artificial intelligence (Study 4), and oceanic currents (Study 5) in experiments evokes gratitude for these nonhuman entities by eliciting a perception of them as responsive benefactors. Receiving increased imagined (Study 5) or actual (Study 4) benefits in the studies further strengthens the effect. In turn, the thankful feeling enhances humans' trust for anthropomorphized nonhumans (artificial intelligence; Study 4) and the former's urges to protect the latter (nature; Studies 3 and 5). Overall, since the generation of gratitude for nonhumans rests on assigning human characteristics to them, the present research implies a mechanism to evoke gratitude from humans for other humans as well.

Keywords: gratitude, nonhuman, anthropomorphism, perceived responsiveness, ecobehavior

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> When you arise in the morning, give thanks for the morning light, for your life and strength. Give thanks for your food, and the joy of living. If you see no reason for giving thanks, the fault lies with yourself.
>
> —Tecumseh, Shawnee chief and warrior, 1768-1813

On April 15, 2025, OpenAI CEO Sam Altman claimed on social media that his company had spent "tens of millions" on electricity, just for the company's ChatGPT to process users' "thank you" messages for the artificial intelligence (AI; Altman, 2025). Many

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echo Altman's viral post and find such gratitude for machines unintelligible, laughable, or wasteful (e.g., Wilkins, 2025). However, the expenditure speaks to the fact that many others feel sensible, normal, and even responsible to show appreciation for all kinds of beings, from humans to nonhumans and from the animate to the inanimate (as documented by Boleyn-Fitzgerald, 2016; Owens & Patterson, 2013). Leaving this appreciative sentiment for nonhuman objects mostly unexplored, scientific studies on the origin of *gratitude* (Algoe, 2012; McCullough et al., 2001)—the warm, fuzzy feeling that one typically experiences after receiving goodwill from others—essentially assume that humans only direct this emotion toward other humans. To our knowledge, little empirical work has systematically addressed what gratitude for nonhumans is and who experiences it. This research, therefore, presents a novel reinterpretation of gratitude that allows for nonhumans and provides evidence for the key role of *anthropomorphism* (Waytz, Cacioppo, & Epley, 2010) in its generation.

Existing Theories on Gratitude

Two functionalist theories in affective science address the origins of gratitude. Not formally named, the earlier theory (McCullough et al., 2001) tackles the emotion from a social-exchange perspective. Building on this foundation, the later *find, remind, and bind theory* (Algoe, 2012) examines gratitude in the framework of relationship science.

The Social-Exchange Theory

McCullough et al. (2008) theorized that the feeling of gratitude evolved to maintain a balance of resources among group members. To fulfill the function, the emotion first measures the size of debts: the heavier the debts, the stronger the gratitude. In the lab, experiments found that participants experienced more gratitude toward other participants after receiving more raffle tickets from them (Tsang, 2007). In the field, the incoming sorority "little sisters" also felt more appreciative of their "big sisters" if these senior members gave their junior counterparts more expensive gifts (Algoe et al., 2008).

Second, gratitude motivates beneficiaries to restore a balance of resources. For instance, when led to believe someone had benefited them in the lab, participants became grateful and intended to repay the benefactors (Tsang, 2006). Naturalistic observations also reveal a high (the highest among all demonstrations of gratitude covered) and statistically indistinguishable level of reciprocation following the induction of the emotion of gratitude in both individualist (the United States) and collectivist (Taiwan) countries (Chang & Algoe, 2020).

Finally, McCullough et al. (2008) argued that gratitude facilitates both short-term, localized, and long-term, generalized resource equality. The rationale is that beneficiaries' expressions of gratitude would lower their benefactors' perceived risk in investing in them again. Such recurring investments not only establish persistent exchanges between both parties but also gradually form a belief system that enables investments in those outside of the original interactional dyads. Empirically, practicing gratitude enhances people's dispositional, target-free trust (Drążkowski et al., 2017). Having previously received help motivates individuals to assist newly encountered third parties (Bartlett & DeSteno, 2006). This creates a "pay-it-forward" chain of *upstream reciprocity* that may eventually connect all members of a group (Chang et al., 2012). The literature thus suggests, phenomenologically, gratitude enhances large-scale resource regulation in collectives.

The Find, Remind. and Bind Theory

Extending the social-exchange view into relationship science, Algoe (2012) theorized that gratitude fosters not only exchange relationships but also communal ones. As reflected in the theory of McCullough et al. (2008), individuals in exchange relationships focus on resource distribution and selfish benefits through transactional exchanges. On the other hand, individuals in communal relationships focus on social bonding and selfless benefits for partners through mutual care (Clark & Aragón, 2013; Clark et al., 2017). Accordingly, when someone receives help that elicits gratitude, the feeling signals to the individual an encounter with a high-quality, benevolent social partner; the emotion *finds* worthy partners for individuals. Although this process appears equivalent to the debt-measurement function proposed by McCullough et al., Algoe emphasizes that the thankful feeling does not reflect the quantity of benefits but rather the magnitude of the underlying benevolence. In communal relationships, a person pays attention to their partner's motivation rather than their own compensation; the individual looks for responsive others rather than resourceful ones.

Beneficiaries may thus feel subjective gratitude for the generosity of benefactors, regardless of the objective utility of the encounters. Insofar as beneficiaries perceive their benefactors as caring, validating, and understanding—*responsive*, in short (Reis & Clark, 2013)—the former will feel appreciative for the latter. The aforementioned sorority study indeed supports this communion-based understanding of gratitude: Gift recipients' (little sisters') evaluations of gift-givers' (big sisters') responsiveness fully mediated the effect of gift cost on recipient gratitude (Algoe et al., 2008). Benefactors likewise feel positive toward beneficiaries when the latter's thanks for the former highlight how thoughtful rather than how expensive the benefits are (Park et al., 2020). That is, the party that receives gratitude expressions would also agree that their gratitude-expressing counterpart should prioritize their generosity over their utility.

Moreover, gratitude renders the memories of beneficial interactions more cognitively accessible and rewarding to recall when the emotion marks the experiences with its positive valence (Algoe, 2012). In other words, gratitude helps *remind* beneficiaries of their benefactors. The beneficiaries will subsequently offer care in return for the benefactors when they meet again. As a result, gratitude will *bind* both sides closer together over time (Algoe, 2012).

Note again that this social bonding, built through gratitude, is communion-based and partner-intention focused, as opposed to being exchange-based and self-interest focused. Past research has measured the ostensible expressive quantity in gratitude expressions (by their duration) and has statistically controlled for it. Still, a quality in the expressions that highlights benefactors over beneficiaries—presumably a focus on the generosity from the former over the utility for the latter—forecasts the level of responsiveness that the recipients of the expressions perceive in the expressers (Algoe et al., 2016). Within different cultural contexts, communication about feelings of gratitude also occurs in ways that are uniquely meaningful (even if direct reciprocity exists as an additional communication channel, as mentioned; Chang & Algoe, 2020). Put differently, thanking is more for bridging grateful minds than for balancing valuable resources.

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Overall, the evidence supports the updated theory that the emotion of gratitude nurtures benevolence-driven communal ties more than benefits-driven exchange ones.

Benevolence Beyond Benefactors

Despite the updated conceptualization of gratitude, we hold that the emotion's nature remains partly unknown. Both the earlier evolutionary and the later relational accounts theorize exclusively on relationships between human agents, seemingly assuming gratitude is for humans and from humans. Nevertheless, the human experience habitually demonstrates humanity's capacity to feel this emotion for nonhuman targets. Literary works have documented it: In poetry, poet E. E. Cummings (1950; reprinted in the cited 1994 collection) loudly proclaims, "I thank You God for most this amazing/day:for the leaping greenly spirits of trees/and a blue true dream of sky; and for everything/which is natural which is infinite which is yes." The speaker directly addresses the divine, giving thanks for the beauty of the natural world. Discussing his state of existence, American transcendentalist Thoreau (1856/1958) wrote "I am grateful for what I am and have. My thanksgiving is perpetual. It is surprising how contended one can be with nothing definite—only a sense of existence." Thoreau directs his gratitude toward the very state of human existence in a celebration of his human faculty. Both examples show a clear, artistic understanding of gratitude to nonhuman entities and even ephemeral concepts.

Corroborating the literary depictions, empirical studies (e.g., Boleyn-Fitzgerald, 2016) have also reported the human tendency to thank nonhumans. The phenomenon spans adults and children as young as seven (Owens & Patterson, 2013); the targets include animals (e.g., pets), deities (e.g., angels), natural (e.g., weather) and built environments (e.g., schools), as well as basic needs (e.g., food), material objects (e.g., bicycles), events, and activities (e.g., holidays). None of these is human. In other words, the existing theories on gratitude are most certainly incomplete, even if they are correct. The literature needs to transcend the separation between human and nonhuman beings.

Gratitude Is for Humanity, Not Humans

Answering the call, we reinterpret the theories and propose that this positive feeling of gratitude is not an emotional reaction to humans but to *humanity*, the essential psychological quality that makes people *people*, a quality that mainly manifests itself through the abilities of intention, volitional agency, and conscious free will (Waytz, Cacioppo, & Epley, 2010). This proposal of ours stems from the philosophical problem of *other minds*: How can anyone ensure that others around them have conscious minds and are not, for instance, mindless robots so sophisticatedly designed and therefore indiscernible from real, *minded* humans? Albeit counterintuitive, the consensus nowadays is that they cannot. They merely believe in the consciousness and intentions of others without definite proof (Godfrey-Smith, 2016). Other minds are a subjective perception in the eyes of the beholder, never an objective fact. As a result, any-*thing* bestowed the privilege of perceived humanity may be deemed a human (Waytz, Gray, et al., 2010) and then—we argue—a probable target of gratitude.

Supporting the hypothesis, studies have observed indirect evidence that perceiving humanity in humans—through either their perceived intentions, volitional agency, or conscious free will—is fundamental for eliciting the perceiver's gratitude for the targets. For example, participants without a belief in volitional agency reported relatively little thankfulness in everyday life (MacKenzie et al., 2014). When experiments activated such a free will-discounting ideology in individuals, they also recalled fewer grateful memories and showed less appreciation for favors received from others in the lab (MacKenzie et al., 2014). Moreover, beneficiaries' ability to counterfactually imagine that their benefactors could have chosen not to benefit them intensifies their thankful feelings for the benefactors (Koo et al., 2008). Put differently, without seeing the benefactors as autonomous and intentional when being kind, the beneficiaries do not appreciate their efforts as much, even if the benefactors are objectively human. Finally, a personality trait that focuses on the material utility of objects as opposed to the intentionality that created the objects (i.e., materialism) negatively predicts emotional gratitude and behavioral giving (Walker et al., 2016). For that reason, scholars even call the materialist attitude one of the "thieves of thankfulness" (Solom et al., 2017). Taken together, the literature supports the notion that individuals experience gratitude for the sensed humanity in others to benefit themselves, but not for the mere beneficial results that the others create.

Anthropomorphism Drives Gratitude for Nonhumans

However, what kind of individuals see humanity in nonhuman entities as they do in humans? That one can dehumanize fellow humans and mentally deprive them of the qualification for thanks does not mean that one can reversely personify nonhumans and grant them that privileged status. Here, studies have revealed not only the capacity but also the prevalence of humans' everyday *anthropomorphism* tendency, or the tendency to psychologically transform (i.e., -morphism) nonhumans into humans (i.e., anthropo-) and then find humanity in the nonhumans (Waytz, Cacioppo, & Epley, 2010). This disposition is also called personification (which is synonymous to anthropomorphism; Weisman et al., 2017) and mind perception (which stresses anthropomorphism being a perception; H. M. Gray et al., 2007) in the literature; it mostly varies from person to person as a trait (Waytz, Cacioppo, & Epley, 2010) but may also fluctuate from time to time as a state (e.g., when being experimentally manipulated; K. Gray, Knobe, et al., 2011). For instance, research (Chang et al., 2017; H. M. Gray et al., 2007; K. Gray, Jenkins, et al., 2011; Weisman et al., 2017) has found that different individuals perceive different degrees of human mental faculties in different nonhumans ranging from animals (e.g., frogs and beetles), natural objects (e.g., trees), material goods (e.g., stationary), legal entities (e.g., Google), robots (including hardware and software), gods, abstract mental states (e.g., the emotion of jealousy as an agentic "green-eyed monster" from Shakespeare's *Othello*), and even dead persons as if they still think and feel.

Furthermore, people relate and interact with humanity in nonhumans instead of simply perceiving it. A review concludes that such perceived humanity is the basis for emotional attachment to personified nonhuman entities (Wan & Chen, 2021); the attachment is analogous to the relationships that gratitude builds between humans. Similarly, perceiving a mind in a being determines whether individuals believe the being deserves care, which gratitude produces (Algoe, 2012). For example, one can more easily agree to euthanize humans when one no longer perceives the existence of

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minds in them (e.g., in persistent vegetative states). In the meantime, nonhumans with perceived minds (e.g., vertebrate animals, relative to, say, rocks) are often legally protected (K. Gray et al., 2012). These studies imply that individuals form relationships with perceived humanity rather than with physical bodies of either humans or nonhumans. Since gratitude functions to build relationships (Algoe, 2012), any-*thing* that seems to possess humanity and, in turn, relatability may therefore be the rightful target of thankfulness.

Taking Stock

Overall, the literature supports our theory that anthropomorphism serves as the basis of gratitude toward nonhuman targets. The underlying emotional appraisal of such anthropomorphized gratitude is essentially the same as that of interpersonal gratitude since both are directed toward perceived humanity. As such, feeling thankful for nonhuman entities may evoke subsequent reciprocating behavior toward nonhumans. As reviewed, the evidence maintains that humans appreciate each other for the goodwill they perceive in one another rather than for the goodness they receive. Humans also perceive such benevolence in nonhumans and report grateful feelings for them. Most relevant to our research, studies by Tam (2022) have discovered that individuals' everyday appreciation for the natural environment varies with their animism, or the tendency to personify nature. The recent work on gratitude for God also finds the emotion to track with participants' religiosity (Rosmarin et al., 2011; Van Cappellen et al., 2024), the other classic type of anthropomorphism (Guthrie, 1995; Guthrie & Porubanova, 2024).

Gaps in the Literature

These emerging investigations focus on natural nonhumans of interest (i.e., nature and deities) and are primarily correlational in design. The question remains: Does the association between anthropomorphism and gratitude apply to artificial nonhumans, and does anthropomorphism cause gratitude? Plants, animals, and God could be easily personified. This might not be the case for one's cars or boats. We have further theorized the phenomenon's underlying mechanism and downstream consequence: Perceived humanlike responsiveness in anthropomorphized nonhumans engenders reciprocated care for them. The current research aims to scrutinize all these predictions.

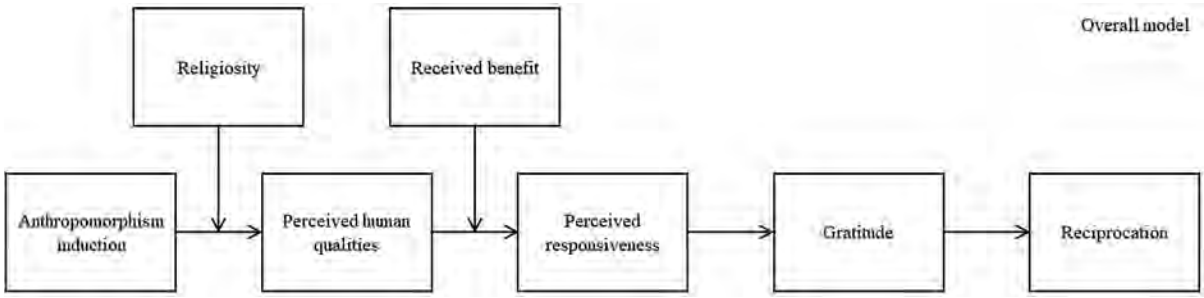
The Current Research

Addressing gratitude for nonhuman targets, we hypothesized that (see Figure 1), as individuals anthropomorphize and perceive a mind in nonhuman entities, the individuals may attribute their received benefits to the objects' perceived humanlike agentic qualities. The targets will subsequently appear as responsive and therefore appreciable humanlike partners. As would be the case for humans, the thanks will further motivate reciprocation toward the personified nonhuman benefactors.

Five studies tested these hypotheses. We report all relevant measures, manipulations, and the planning for the samples. In Study 1, we surveyed the overall nonintrusive everyday direct covariation between participants' anthropomorphism dispositions and grateful feelings for both natural (e.g., animals) and artificial (e.g., machines) nonhumans. To establish causality, a series of experiments further manipulated participants' anthropomorphism; Studies 2 and 3, specifically, led individuals to see nonhumans—a computer in the former and a rainforest in the latter—from either an anthropomorphizing or a nonanthropomorphizing perspective. Participants then reported their levels of perceived responsiveness in the targets and experienced appreciation for them. In Study 3, individuals also indicated their likelihood to repay nature as the outcome of felt gratitude.

Elaborating on the main effect of anthropomorphism, Studies 4 and 5 examined a boundary condition for gratitude toward nonhumans: Only with benefits will the beneficiary experience gratitude for the benefactor. The emotion reflects good-*will* as well as *good*-will. Even though finding benevolence out of little benefit is a possibility (e.g., in domestic violence cases where the victims believe the abuses are out of care; Pocock et al., 2020), the perception is practically difficult and therefore, probabilistically unusual. To investigate this moderating effect of benefit, in Study 4, we had participants play a bogus economic game in real-time against a computer. The study first implied to the human players that their nonhuman opponent was either a mindless algorithm or a mind-bearing AI. This nonhuman then treated the human participants with

Figure 1
Overall Conceptual Model of the Present Research



Note. The overall model of our research: From the left, an individual induced with anthropomorphism will see human qualities in the anthropomorphized nonhuman. With the benefit received by the individual, this induced attitude will subsequently elicit a sense of responsiveness perceived in and then gratitude felt for the target, which will eventually translate into the individual's reciprocation behavior toward the nonhuman. We also address the moderating role of religiosity in the elicitation of anthropomorphism.

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different levels of profitable outcomes. Building off Study 4, Study 5 fortified ecological validity by following the same two-dimensional, *Anthropomorphism* × *Benefit* paradigm but operationalizing the benefit dimension with an actual natural phenomenon. In particular, we introduced local participants to a faraway oceanic current that has an ambiguous, simultaneously beneficial and harmful relationship with them. The study subsequently primed individuals to attend to either the positive or the negative impacts, creating two realistic levels of potential benefit. Throughout the process, we also explored the role of dispositional religiosity in inducing personified gratitude, as religion is arguably the most ancient and still the most widespread manifestation of anthropomorphism (Guthrie & Porubanova, 2024).

Study 1: Natural Association Between Anthropomorphism and Gratitude for Nonhumans

The goal of Study 1 (see Figure 2) was straightforward: to confirm the cross-sectional association between anthropomorphism and everyday experiences of gratitude for nonhumans. Participants first reported their dispositions to perceive a few qualities in nonhuman beings, among which some can only reasonably apply to humans (e.g., having a mind). In contrast, other qualities in the measure apply to both humans and nonhumans (e.g., looking good). The individuals then rated their feelings of 20 discrete emotions, which include gratitude, toward two natural and two artificial nonhuman beings that they had interacted with the week before the study. Given that we also assessed unnecessarily human attributes, we use that part of the data to rule out the alternative explanation that any desired qualities (cf. human-only ones) could similarly produce gratitude for nonhumans.

Participants

We aimed to recruit 400 adult U.S. participants through the online participant pool of Prolific. The sample size was determined given that, even if 20% of data ended up being unanalyzable and removed due to failed attention checks (see below), the sample would still render a satisfactory statistical sensitivity of $|\rho| = .16$ (under $\alpha = .05$ and $\beta = .20$), that is, between the 30th ($|\rho| = .14$) and 35th ($|\rho| = .17$) percentiles of all past effects in social psychology reviewed by Lovakov and Agadullina (2021). Put differently, we would still be able to capture at least two thirds of existing findings in the field if this planned sample had been used in those past studies. In the present study, after removing those who finished their surveys ($N = 405$) but failed to "Select 2 = A little" on the first or "Select 4" on the second attention check ($N = 19$, 4.69%), we retained 386 participants (68.7% women; M of age = 48.02, $SD = 10.61$) as the final sample. The sample size achieved a sensitivity of $|\rho| = .14$ for the main effects tested.

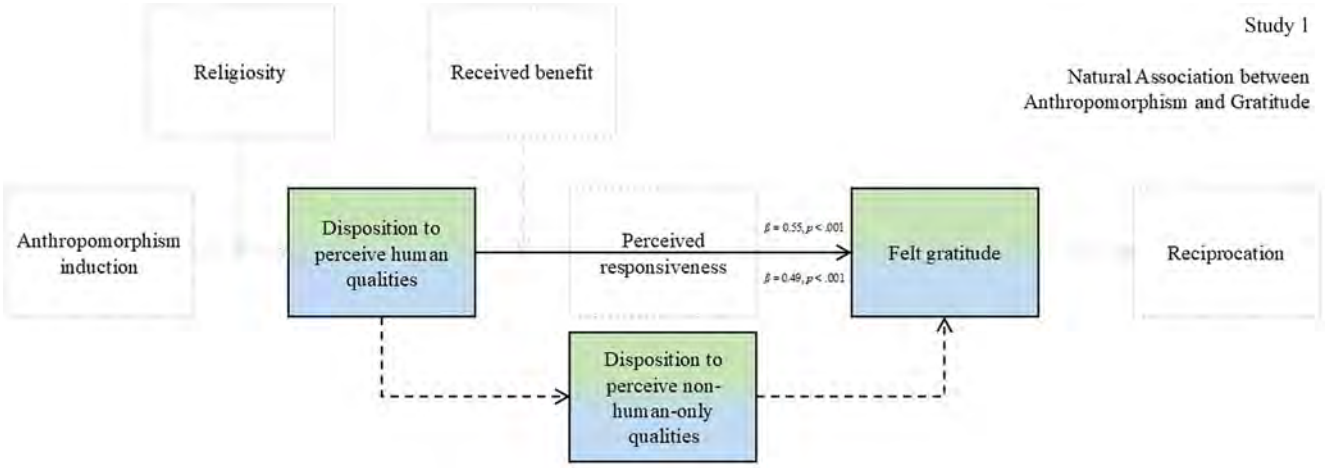
Measures

Dispositional Anthropomorphism (to Perceive Human Qualities)

The anthropomorphism portion of the Individual Differences in Anthropomorphism Questionnaire (IDAQ; Waytz, Cacioppo, & Epley, 2010) was used to assess participants' general tendencies to humanize nonhuman entities. In this 30-item measure, 15 questions assess whether participants see five different human qualities—having a mind, free will, consciousness, intentions, and the ability to experience emotions—in four classes of commonly personified nonhumans—animals (other than humans), spirits and mystical agents, natural objects, and artificial objects. An example question is, "To what extent does a car [an artificial object] have free will [a human attribute; the definition was offered in the measure instructions]?" In the present study, participants rated the items on a 6-point Likert-type scale with points 1 and 6 labeled 0 = *not at all* and 5 = *very much*, respectively, and the other points with only the

Figure 2

Model of Study 1: The Natural Association Between Anthropomorphism and Gratitude



Note. As a proof of concept, Study 1 measured the naturalistic associations between participants' dispositional anthropomorphism and actual everyday gratitude experienced for artificial and natural nonhumans, colored blue and green, respectively. Furthermore, dashed dark lines indicate the alternative explanation tested and ruled out: The proposed effect of anthropomorphism cannot be reduced to the effect of any desired, nonhuman qualities. Grayed components are constructs hypothesized in the full model but not included in the study. The βs are direct effects; see results for more details. We use the formatting scheme throughout the article in all figures. See the online article for the color version of this figure.

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numbers 1–4. We averaged across the fifteen ratings to form the index; the internal consistency α of this part of the scale was .84.

Baseline for Dispositional Anthropomorphism (to Perceive Unnecessarily Human Qualities)

In addition to the anthropomorphic ones, there are 15 non-anthropomorphic questions in the IDAQ, making 30 items total in the scale. This portion of the measure taps into whether people perceive five unnecessarily human qualities—being durable, useful, good-looking, active, and lethargic—in the same four classes of targets. An instance is "To what extent is a river [a natural object] useful [nonhuman; the definition provided]?" These extra nonfocal items help cover the true and somewhat irrational key construct of anthropomorphism. They may also—as we did and report below—be applied to control for a nonanthropomorphism-specific responding pattern by which a person gives similar scores to all attributes, human and nonhuman alike. As its anthropomorphism counterpart, this portion of the IDAQ was rated on the same scale and scored similarly; its internal consistency α was .68.

Gratitude for Nonhumans

We adapted the Modified Differential Emotions Scale (mDES; Fredrickson, 2013) to measure people's gratitude for nonhumans. The mDES is a comprehensive emotion assessment composed of 20 emotion trios, 10 positive and 10 negative, such as "grateful, appreciative, or thankful" (in one item) and "sad, downhearted, or unhappy." The measure has been used widely with modifications to the instructions for different research contexts (e.g., Dwyer et al., 2019).

In the present study, the instructions of the mDES first read to participants: "Write down four nonhuman objects—two artificial and two natural—that you encountered (e.g., used, played, saw, heard, etc.) in a positive mood in the past week." A few examples of how to encounter the objects were provided here, so the participants would know better what we meant by the broad term. In the meantime, we avoided potentially anthropomorphized verbs such as "play" (e.g., with pets) or "collaborate" (e.g., with robots), for they might imply that there were things possessing such agency to react like humans. Moreover, we explicitly asked for both natural and artificial nonhuman entities, so neither would be missed, and both were tested in parallel. Finally, given that gratitude took the appraisal of benefit as a necessary (but not sufficient, as argued above) condition, we required the encounters to be positively valenced. The mood could nonetheless be elicited by any anthropomorphizing or nonanthropomorphizing reason; participants could feel benefited without finding the nonhumans benefiting, thus appreciable.

For each of the four objects nominated, one after another, the participants were told to "indicate the greatest amount that you've experienced each of the following feelings [in the mDES] in your encounter with the object." To ensure the feelings were meant for the target and not coincidental in the event, the measure was worded explicitly "Toward [a nominated object piped in here] in my encounter with it last week, I felt" and then responded on a 5-point Likert-type scale, with points 1 through 5 labeled *very slightly* or *not at all*, a *little*, *moderately*, *quite a bit*, and *extremely*. Here, our focus with the scale was the gratitude trio (the one above). The scale was repeated four times, once for each of the two artificial and the two natural entities. We averaged both ratings within each type of targets to form the indices of gratitude: one for artificial nonhumans (international consistency $\alpha = .75$) and the other for natural (international consistency $\alpha = .78$) nonhumans.

Last, it might be worth noting that the mDES was preferred to other similarly popular comprehensive emotion measures (e.g., the Positive and Negative Affect Schedule; Watson et al., 1988). For one, the mDES encompassed 60 emotion terms, theoretically organized within 20 items. This means efficiency and thus reliability as well as validity: Every single item now had three different emotions (cf. only one in the Positive and Negative Affect Schedule) depicting their overlap as the underlying construct of the item. For instance, the focal gratitude trio fully reproduced the commonly used three-item state-gratitude measure of the Gratitude Adjective Checklist (McCullough et al., 2002), which assesses the emotion by breaking the three-adjective mDES gratitude item into three individual questions, each with one of the same three adjectives. Put another way, the mDES gratitude question could be deemed equivalent to the whole measure of the Gratitude Adjective Checklist. It can therefore be used independently, even with only one item in the questionnaire. In addition, the mDES strikes a balance between high- and low-arousal emotions. By contrast, most existing scales (again, cf. the Positive and Negative Affect Schedule) are biasedly leaning toward high-arousal emotions and cannot fairly capture the two-dimensional affective space.

Transparency and Openness

All data and materials of the present study and all other studies in the research are available on the Open Science Framework (Chang, 2026).

Analysis Strategy

We regressed the participants' gratitude (for natural entities, $M = 3.44$, $SD = 1.22$; for artificial entities, $M = 3.10$, $SD = 1.21$), once for each of both kinds of targets, on the persons' dispositional anthropomorphism ($M = 2.37$, $SD = 0.70$), anticipating positive associations. To clear the concerns that the effects could appear for not only human qualities but also any desired qualities sensed in the evaluated objects, the set of regression models was repeated with the anthropomorphism baseline ($M = 3.76$, $SD = 0.56$) being added as a control variable.

Results

The data lent support for the hypothesis as expected. The analysis (see Figure 2 for a summary; also see Supplemental Materials for full detailed reports) indicated that anthropomorphism significantly predicted grateful feelings felt for both natural ($\beta = 0.55$, $SE = 0.08$, $df = 384$, $t = 6.57$, $p < .001$) and artificial ($\beta = 0.49$, $SE = 0.08$, $df = 384$, $t = 5.81$, $p < .001$) nonhuman beings. The effects stayed when we controlled for the anthropomorphism baseline (for natural entities, anthropomorphism β on gratitude = 0.28, $SE = 0.10$, $df = 383$, $t = 2.87$, $p = .004$; for artificial entities, anthropomorphism β on gratitude = 0.21, $SE = 0.10$, $df = 383$, $t = 2.08$, $p = .038$). Together, it seemed that the more a person was prone to anthropomorphizing the things around them, the more the person was to feel thankful for the things they encountered.

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Study 2: Anthropomorphism Induces Gratitude for Nonhumans Through Perceived Responsiveness

Building off Study 1, Study 2 (see Figure 3) examined the causal influence of anthropomorphism on gratitude toward nonhuman targets. The experiment either strengthened (i.e., the anthropomorphizing condition) or weakened (the nonanthropomorphizing condition) the participants' anthropomorphic attitudes toward a commonly personified object—the computer (Waytz, Gray, et al., 2010)—and measured if those in the anthropomorphizing condition appreciated the entity more. We further assessed and tested perceived responsiveness after the manipulation as the theoretical mediator leading up to gratitude, as past studies had frequently done (e.g., Algoe et al., 2008).

Participants

With the larger-than-anticipated effect sizes seen in Study 1, we slightly but cautiously brought down the target sample size to 350, again on Prolific for adult U.S. participants, which would render a sensitivity of $d = 0.34$ (or $|\rho| = .17$; under $\alpha = .05$ and $\beta = 0.20$) when 20% data were removed. After cleaning out the responses of those who finished the study ($N = 353$) but failed to at least slide to the lower/left one-fourth on a smooth slider when being asked to "slide to the very left" or to type in more than ten characters in the writing manipulation ($N = 21$, 5.95%), we retained 332 participants (54.5% women; M of age = 40.08, $SD = 13.96$) as the final sample. The sample size achieved a sensitivity of $d = 0.31$ (or $|\rho| = .15$) for the main effects tested.

Procedure

After consenting to take part in the study and finishing standard demographic questions, those who were randomly assigned to the anthropomorphizing condition read a passage wherein the computer was personified. The priming was designed based on the finding that language is humans' natural "window into mind perception" (Schweitzer & Waytz, 2020) and that several past experiments had succeeded in inducing anthropomorphism by similar linguistic methods (e.g., Butterfield et al., 2012; Chandler & Schwarz, 2010; Tam et al., 2013; Zhou et al., 2018). As in these existing studies, the computer was described in the present study using words that objectively only apply to humans. It might also be worth noting that we operationalized perceived humanity as a unidimensional variable here and throughout the research, thus simultaneously manipulating its dimensions of influencing/outputting to and sensing/inputting from the world (H. M. Gray et al., 2007). The decision was made because, although the dimensions' divergence can be statistically detected (H. M. Gray et al., 2007), they were still highly correlated in past studies (Tzelios et al., 2022), found so in the participants' everyday attitudes in Study 1, and explicitly recommended to be applied as a unified construct that varies on a single continuum of human-likeness (Tzelios et al., 2022). As a result, our anthropomorphizing stimulus was written as follows:

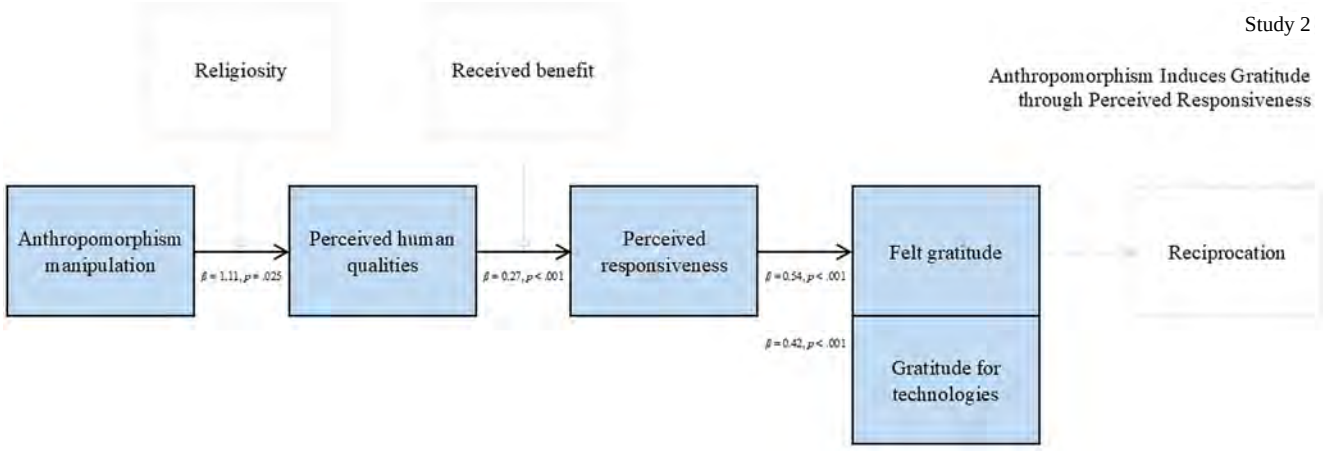
> The minds of computers are getting smarter and smarter every day. In addition to their abilities we know already, researchers have reported that computers are now capable of unbiasedly understanding human emotional feelings. This is because—some argue—like humans, computers might be self-aware and actually conscious "inside"; they not only can, but sometimes "want" (or hesitate) to do what humans need them for—they are intentional! As such, even if it is still debatable, we all should consider the possibility that computers do have or will soon have free will like you and me.

By contrast, the nonanthropomorphizing stimulus read as follows:

> The processors of computers are getting faster and faster every day. In addition to their functions we know already, researchers have reported that computers are now useful for unbiasedly classifying human emotion expressions. This is because—some argue—unlike humans, computers are not self-aware and simply empty "inside"; they only can, but have never "wanted" (or hesitated) to do what humans need them for—they are non-intentional! As such, even if it is still debatable, we all

Figure 3

Model of Study 2: Anthropomorphism Induces Gratitude Through Perceived Responsiveness



Note. Study 2 manipulated the participants' anthropomorphism for an artificial nonhuman, the computer, and then examined if the attitude promoted gratitude for the object, assessed by two standalone measures and by first inducing responsiveness perceived in the target. Grayed components are constructs not included in the study. See the online article for the color version of this figure.

should consider the possibility that computers do not have and will hardly have free will like you and me.

Right after reading one of the above passages, in the second half of the manipulation, the participants in both groups were requested to write and "express your thoughts and feelings about computers and their importance in your life." This task was to increase their involvement and sense of active participation. The entire reading–writing task took two and a half minutes before the study automatically proceeded. The participants then rated their levels of anthropomorphization of the computer, responsiveness seen in it, and emotions felt for the target, among which gratitude was included.

Measures

Anthropomorphism

Following Study 1, we adapted the IDAQ to check the level of anthropomorphization of the computer after the manipulation. In particular, the participants rated the target on each of the five human attributes in IDAQ (similarly with their definitions provided), on a negative-10-to-positive-10 smooth slider with the two ends labeled *not at all* and *very much*, respectively. The five items were averaged to form the index; their internal consistency α was .94.

Gratitude for Nonhumans

Felt Gratitude. As in Study 1, we administered the mDES to assess individuals' emotions "while writing about computers." The answer was reported with a negative-10-to-positive-10 smooth slider, on which the two ends were labeled *strongly disagree* and *strongly agree*, respectively.

Gratitude for Technologies. We included a second standalone gratitude assessment dedicated to technologies since the measure of perceived responsiveness was blended in the mDES (see below) and went with that of felt gratitude. The measure thus potentially suffered the common method/set bias. Specifically, we adapted the eight-item Gratitude to Nature questionnaire (Tam, 2022), by replacing the words "nature" and "natural world" in the original items with "technologies" (plus necessary grammatical changes). This concluded the revision for all but two questions, resulting in items such as "I want to give thanks to *technologies* [originally, nature; not italicized for respondents] for *their* [its] support to my life." To make both unfinished questions read more naturally while preserving the spirits of the original items, the two were further modified as "Even something as simple as seeing a *delicate vase* [beautiful flower] makes me feel grateful toward the *technologies that produce it* [nature]" and "Whenever I eat something delicious, I feel grateful toward *technologies* [the natural world] for *their roles in food production* [its provisions]." Participants rated all these items on a negative-10-to-positive-10 smooth slider, on which the two ends were labeled *strongly disagree* and *strongly agree*, respectively; the mean score was used as the indicator. The scale's internal consistency α was .91.

Perceived Responsiveness

Following the definition of responsiveness as to "understand, validate, and care for" another person (Reis & Gable, 2015), we added an extra trio—feeling "understood, cared for, and validated"—in the mDES as the measure of perceived responsiveness. Individuals responded to the item on the same slider as with the rest of the mDES.

Analysis Strategy

With the PROCESS program, we fit a single serial mediation model (Model 6, with indirect effects estimated with 5,000 bias-corrected bootstrapping resamples) from experimental condition (the nonanthropomorphizing and the anthropomorphizing group were coded 0 and 1, respectively; $N = 168$ for the latter), to anthropomorphism state ($M = -6.69$, $SD = 4.54$), perceived responsiveness ($M = -0.69$, $SD = 5.66$), and lastly to each of both gratitude assessments (for felt gratitude $M = 3.45$, $SD = 5.32$; for gratitude for technologies, $M = 1.40$, $SD = 4.46$). The manipulation check of state anthropomorphism was included in the chain per the suggestion of Lench et al. (2014) to temper the concern that the manipulation, even when successful on the manipulation check, could still produce the proposed effect by unmeasured hidden confounding factors as opposed to the focal hypothesized manipulated state. In comparison, the indirect path through the manipulation-checked key construct would serve as a theoretically derived conservative test of the hypothesis.

Results

Consistent between the two gratitude assessments, the results (see Figure 3 for a summary; see Supplemental Materials for full detailed reports) showed support for our predictions. It was found that the manipulation was successful ($\beta = 1.11$, $SE = 0.50$, $df = 330$, $t = 2.25$, $p = .025$) and the induced anthropomorphism significantly increased the responsiveness sensed in computers ($\beta = 0.27$, $SE = 0.7$, $df = 329$, $t = 3.98$, $p < .001$), which then translated into gratitude for them (for felt gratitude, $\beta = 0.54$, $SE = 0.04$, $df = 328$, $t = 12.23$, $p < .001$; for gratitude for technologies, $\beta = 0.42$, $SE = 0.04$, $df = 328$, $t = 11.49$, $p < .001$). Bolstering the hypothesis, both mediation chains from the beginning to the end were significant in themselves too (to felt gratitude, $\beta = 0.16$, $SE = 0.08$, 95% CI [0.02, 0.34]; to gratitude for technologies, $\beta = 0.13$, $SE = 0.07$, 95% CI [0.01, 0.27]). In summary, we discovered that an elicited anthropomorphizing state engendered the participants' gratitude for computers by first making the machines appear responsive to the users.

Study 3: Anthropomorphism-Induced Gratitude for Nonhumans Promotes Reciprocation

The goal of Study 3 (see Figure 4) was twofold. First, it applied the same two-group experimental structure as Study 2 but extended the phenomenon from artificial to natural nonhuman entities, namely forests (Waytz, Gray, et al., 2010). Moreover, we measured the participants' subsequent intention to reciprocate and care for the environment.

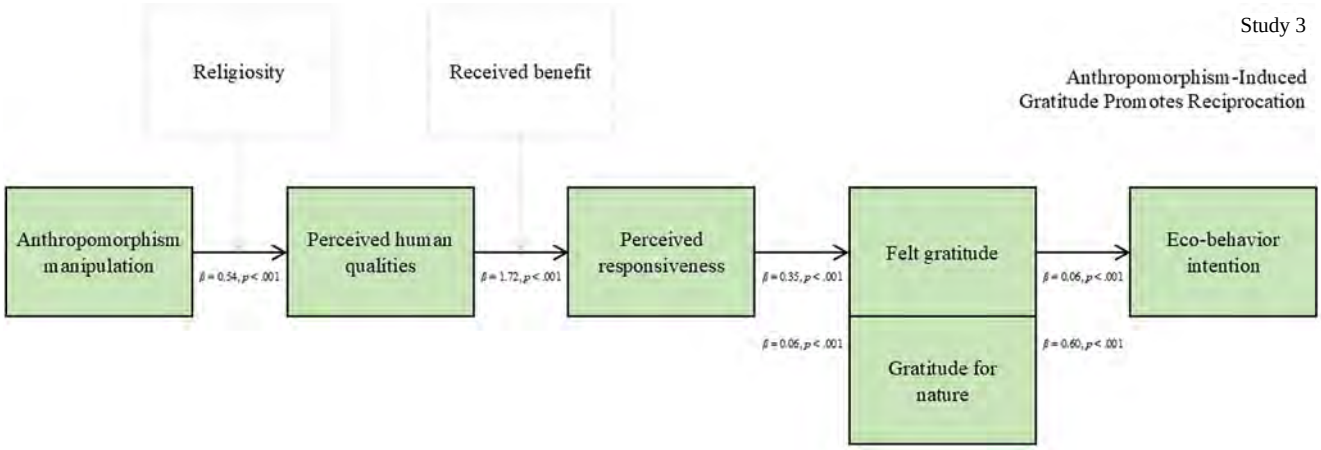
Participants

Having observed the supporting findings in Study 2, we again reduced the target sample size now to 300 on Prolific for adult U.S. participants, which would render a sensitivity of $|d| = 0.36$ (or $|\rho| = .18$; under $\alpha = .05$ and $\beta = .20$) when 20% data were removed. After

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Figure 4

Model of Study 3: Anthropomorphism-Induced Gratitude Promotes Reciprocation



Note. Study 3 manipulated participants' anthropomorphism for a natural nonhuman, the Amazon Rainforest, and then examined if the attitude promoted gratitude for the object—assessed by two measures—by first inducing responsiveness perceived in the target. Building off Study 2, Study 3 further tested the intention to protect the environment as a way to repay nature after feeling thankful for it. Grayed components are constructs not included in the study. See the online article for the color version of this figure.

cleaning out the responses of those who finished the study ($N = 296$) but failed to choose 1 = *absolutely untrue* to the statement "I was born on Mars," failed to "Select the second option from the right [which was '4']," or typed in more than 10 characters in the writing manipulation ($N = 41$, 13.85%), we retained 255 participants (54.5% women; M of age = 40.08, $SD = 13.96$) as the final sample. The sample size achieved a sensitivity of $|d| = 0.35$ (or $|\rho| = .17$) for the main effects tested.

Procedure

The study design was the same as Study 2, except now the target of anthropomorphization in the reading-writing task was the Amazon rainforest, or Amazonia. Another minor difference was that the task here took more time—4 min—given the longer passage to read. For instance, parts of the anthropomorphizing text (see Supplemental Material for full detailed stimuli) read as follows:

> In addition to digesting carbon dioxide and providing oxygen, Amazonia serves as a shelter against harmful contaminants. When the pores on the trees breathe, the trees catch and trap pollutants such as chlorine, sulfur dioxides, and fluorides from dispersing.

and

> Indeed, recent scientific advances have demonstrated that plants are potentially self-aware and are in a sense conscious inside—they can, and sometimes intentionally want or hesitate to do what humans need them for (this is called panpsychism).

Instead, their counterpart nonanthropomorphizing text read as follows:

> In addition to fixing carbon dioxide and synthesizing oxygen, Amazonia is a filter against harmful contaminants. When the pores on the trees are open, the trees are like traps that prevent pollutants such as chlorine, sulfur dioxides, and fluorides from dispersing.

and

> Although recent scientific advances have demonstrated that plants aren't self-aware and are in a sense empty inside—they can, but have never intentionally wanted or hesitated to do what humans need them for (this is called physicalism).

After the reading portion, participants similarly wrote about their thoughts and feelings for Amazonia's importance, before proceeding to report their state anthropomorphism, perceived responsiveness in the trees, gratitude felt for Amazonia, and gratitude for nature (two measures, as in Study 2), and, finally, the extent to which they would like to take a series of environmental actions.

Measures

Anthropomorphism

The measure was the same as in Study 2, except against "the Amazon rainforest" and being reported on the same 5-point scale as in Study 1. The internal consistency α here was .92.

Gratitude for Nonhumans

Felt Gratitude. Same as in Study 2, except for "the Amazon rainforest."

Gratitude for Nature. The original Gratitude to Nature scale (Tam, 2022; modified in Study 2 for technologies) was applied. The questions were rated on a 5-point Likert-type scale where points 1 and 5 were labeled *strongly disagree* and *strongly agree*, respectively. The internal consistency α of the scale was .91.

Perceived Responsiveness

Same as in Study 2, except again for "the Amazon rainforest."

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Intention for Ecobehavior

Analogous to the reciprocation that people show for their human benefactors when experiencing gratitude, the Environmental Behavior questionnaire developed by Tam (2013) was included in the study to index one's willingness to repay nature. In particular, the measure consists of twelve concrete personal (e.g., "take a shorter shower to conserve water"), relational (e.g., "encourage friends or family to recycle"), and societal (e.g., "write a letter to the government to support an environmental issue") proenvironmental actions that one may take. For the actions, our participants were asked to report "how much you would like to do each of them in the coming month" on a 5-point Likert-type scale where points 1 and 5 were labeled *not at all* and *very much*, respectively. The average of the items was used to indicate ecobehavior intention; their internal consistency α was .90.

Analysis Strategy

We followed the same analytical scheme as in Study 2, except the mediation now had an added final behavioral-intention assessment, hence, five variables in the chain.

Results

The results (see Figure 4 for a summary; see Supplemental Materials for full detailed reports) supported the hypothesis. As before, the manipulation (the nonanthropomorphizing and the anthropomorphizing groups were coded 0 and 1, respectively; $N = 137$ for the latter) was found successful ($\beta = 0.54$, $SE = 0.14$, $df = 253$, $t = 3.84$, $p < .001$); the induced anthropomorphism ($M = 2.64$, $SD = 1.14$) subsequently elicited the responsiveness perceived in Amazonia ($M = 2.70$, $SD = 5.51$, $\beta = 1.72$, $SE = 0.29$, $df = 252$, $t = 5.88$, $p < .001$), which translated into gratitude for it (for felt gratitude, $M = 6.67$, $SD = 4.03$, $\beta = 0.35$, $SE = 0.04$, $df = 251$, $t = 8.12$, $p < .001$; for gratitude for nature, $M = 4.20$, $SD = 0.70$, $\beta = 0.06$, $SE = 0.01$, $df = 251$, $t = 7.40$, $p < .001$). More so than in Study 2, we further observed that the gratitude led to intention for ecobehavior ($M = 3.71$, $SD = 0.76$; predicted by felt gratitude, $\beta = 0.06$, $SE = 0.01$, $df = 250$, $t = 4.94$, $p < .001$; predicted by gratitude for nature, $\beta = 0.60$, $SE = 0.06$, $df = 250$, $t = 10.22$, $p < .001$), and both mediation chains from the beginning to the end—here, ecobehavior—were significant in themselves (through felt gratitude, $\beta = 0.02$, $SE = 0.01$, 95% CI [0.01, 0.04]; through gratitude for nature, $\beta = 0.03$, $SE = 0.01$, 95% CI [0.01, 0.06]). The study not only conceptually replicated and extended the hypothesized process of anthropomorphized gratitude through perceived responsiveness to natural nonhuman objects, but it also revealed that such gratitude stimulated plans for concrete proenvironmental actions as if the perceiving participants were reciprocating human benefactors.

Study 4: Anthropomorphism Induces More Gratitude for Nonhumans Given More Benefits Received

The major goal of Study 4 (see Figure 5) was to address a limitation in the previous studies and demonstrate that although gratitude responds to good-*will*, it has to respond to beneficial *good*-will. Without a palpable benefit received as the communicative vehicle for benevolence, beneficiaries would find it challenging, if not impossible, to see kindness in benefactors. In practice, the participants engaged with either an ostensibly minded or a mindless computer as in Study 2, now in a real-time exchange game for potential bonus rewards. Manipulating benefit levels, we programed the computer to play either beneficially or not so much for participants, so we could analyze the interaction between anthropomorphism and benefit. Moreover, the design not only had individuals reinterpret old memories about nonhumans generally but also created new online encounters with a specific computerized agent that participants needed to grasp in situ. Accordingly, we made the participants focus on this one fellow player in the game when answering the measures.

Participants

Given the complexity and the seeming delicacy of the present study design, we aimed to recruit 800 adult U.S. participants on Prolific, which would render a sensitivity of $f = .13$ (or $\rho| = .13$; under $\alpha = .05$ and $\beta = .20$) in a factorial ANOVA for our two-by-four, anthropomorphism-by-benefit interaction (see Procedure for detail) when 20% data were removed. After cleaning out the responses of those who finished the study ($N = 795$) but failed to at least slide to the lower/left one-fourth on a smooth slider when being asked to "slide to the very left," slide to the upper/right one-fourth on a slider when being asked to "slide to the very right," or type in "159" when being told "please enter 159" ($N = 35$, 4.40%), we retained 760 participants (45.1% women; M of age = 45.22, $SD = 13.40$) as the final sample. The sample size achieved a sensitivity of $f = .12$ (or $\rho| = .12$) for the focused interaction.

Procedure

The experiment was entirely between-participant and composed of two stages, one for each dimension to manipulate. The first one largely mirrored Study 2, where the participants were randomly assigned to read one of the same two anthropomorphism priming passages with minor revisions (see Supplemental Material for full details on the stimuli). In the second stage, the study went on to inform participants that

> to investigate the possibility [that computes do or do not have a mind, depending on the manipulation assignment], we want to invite you to help us with this research, by playing a game with the artificial intelligence [the anthropomorphizing condition]/machine learning [the non-anthropomorphizing condition] we recently developed.

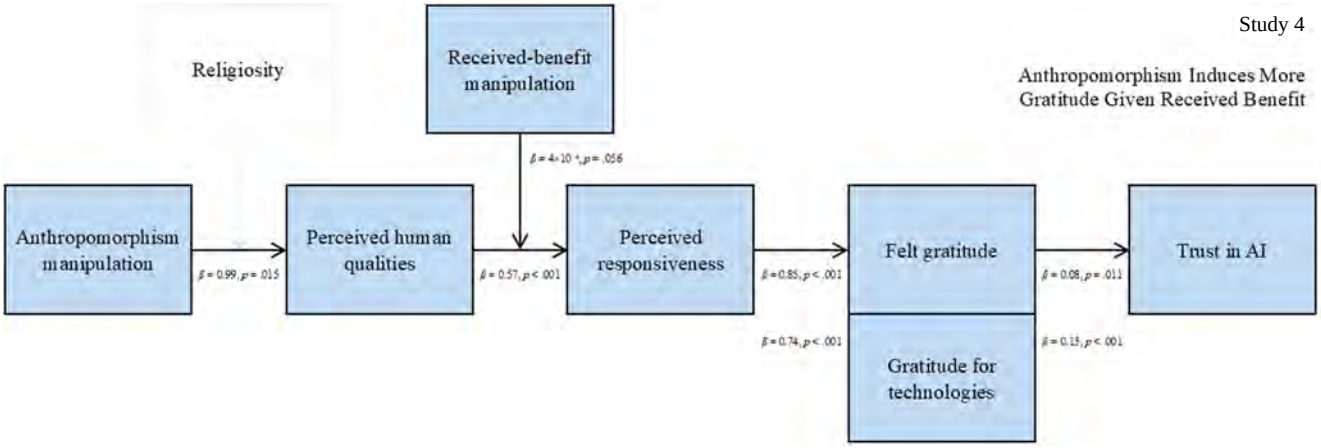
A few pages of explanation for the rules of a classic ultimatum game were subsequently presented; the allocator would split 100 credits in each round of the game for the responder to accept (then both parties got their halves) or decline (then both got nothing).

A bogus random player role assignment subsequently took place, always making the participant the responder, against the computer playing the allocator; the game started with six rounds of exchanges, one after another. In each round, the computer would spend a few intentionally added seconds "considering [anthropomorphizing]/estimating [nonanthropomorphizing]" its split, with a pondering-face-emoji (anthropomorphizing) or a similar-size running-circle animations (nonanthropomorphizing) shown on the screen. Similar implicit linguistic and visual primes were applied in parallel for both groups throughout the process (see Supplemental Materials for details).

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Figure 5

Model of Study 4: Anthropomorphism Induces More Gratitude Given Received Benefit



Note. In addition to manipulating anthropomorphism as in Studies 2 and 3, Study 4 manipulated the benefit that participants received from the anthropomorphized nonhuman, specifically an AI agent. We then measured the same full downstream psychological process as in Study 3, with the reciprocation behavior replaced by trust in AI. Grayed components are constructs not included in the study. AI = artificial intelligence. See the online article for the color version of this figure.

A proposed split then appeared. To manipulate the extent to which the computer played beneficently or not while keeping the game realistic for potential real-world extrapolation, the anthropomorphism manipulation included and crossed four levels of benefit manipulation, thus forming a two-by-four study design. Specifically, a random integer between X ± 10 was drawn from a uniform distribution in each round as the number of credits that "the computer wants to keep" (anthropomorphizing)/"using the computer, the research team wants to keep" (nonanthropomorphizing; we explicitly mentioned the research team so the condition similarly had an intentional agent making decisions). Here, we fixed the X at 10 (making X ± 10 ranging between 0 and 20), 30, 50, or 70 across all rounds for a given participant. We spread out these underlying setpoints from 40 (i.e., the mean of four setpoints) as opposed to the fair 50 (i.e., equal credits for both players) because, empirically, 40 was the usual mean offer from actual humans in similar games. With the variability set to ±10, the manipulation would then cover the benefit spectrum smoothly and uniformly (i.e., with equal possibility everywhere over the range) from 0 (= 10 − 10) to 80 (=70 + 10), resulting in a continuous dimension but not a discrete factor of the benefit manipulation. Following the proposed offer, the participant went on to decide whether to take or turn down the split. No matter the decision, the accumulated credits of both parties so far would be presented on the screen for the participant to keep track of the game and to remind the participant of how the computer had behaved. Whenever they were ready, the participant could begin the next exchange with a new offer from the computer until all six rounds were finished.

Measures

Received Benefit

A strength of the present study built upon the exchange game was that we could objectively manipulate and then meticulously measure participants' levels of being benefited on a continuous scale: The exact credits they walked away with after the game. We actually honored the promise—so it was not a deception—to give out extra participation rewards in direct ratio to the credits.

Anthropomorphism

Same as in Study 2. Here, the scale's internal consistency α was .92.

Gratitude for Nonhumans

Felt Gratitude. Same as in Study 2, except for "the artificial intelligence [anthropomorphizing]/machine learning [nonanthropomorphizing] in the game I just played."

Gratitude for Technologies. Individuals responded to a part of the same gratitude for technologies scale applied in Study 2. However, different from the uses of the assessment in previous studies, in which the evaluated objects were nature and computers overall, here we specifically had participants answer the questions against "the artificial intelligence [anthropomorphizing]/machine learning [nonanthropomorphizing] in the game." We wanted to ensure that the emotion captured by the measure was not only *about* but really *at* the interacted nonhuman target.

For the aim, we then only applied a portion but not the entirety of the scale. The reason was, in the original Gratitude to Nature questionnaire from which the gratitude for technologies measure in Study 2 was adapted, Tam (2022) identified four manifestations of the construct—in intensity, expression, span, and frequency—and includes two questions for each aspect. Here, the four questions of the first two aspects assess the intensity of the participants' thankful feelings and their intention to express thanks in the present moment. In comparison, the other four questions of the last two aspects tapped into the diversity (span) of the targets for which one has experienced gratitude and the frequency at which one has experienced the emotion in one's life so far. Given that this longer timespan was incongruent with our present measure instructions,

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which focused on the game that just happened, we included only the intensity and expression questions in the study. The four items were reported on the same scale and scored the same way as in Study 2; their internal consistency α was .97.

Perceived Responsiveness

Same as in Study 2, except sharing the new prompt with the measure of felt gratitude.

Trust in AI

We deployed the 12 trust-in-AI items from the Attitudes Toward AI scale (Schepman & Rodway, 2020) to tap into participants' attitudinal reactions to AI after the experiment. An example question is, "I am interested in using artificial intelligence systems in my daily life." The questions were rated on a negative-10-to-positive-10 slider with both ends labeled *strongly disagree* and *strongly agree*, and averaged to form the index. The internal consistency α was .92 for the assessment.

In addition, we wanted to take the opportunity to examine the potential impact of appreciating AI outside of the lab. The participants were consequently told what AI roughly is in the world broadly, so we could have them answer the questions against all AI in general. In particular, the instructions for the measure (see Supplemental Material for the full detailed prompt) read as follows:

> Now, let's step back a little and think about modern computer technologies in general (as opposed to the one in the game) … ML/AI [both words at once for all participants] is now everywhere in our lives … For example, it's been used by Google for a very long time to customize search results for users. … without AI, the cameras on self-driving cars would only record their visual fields totally faithfully … really only be a meaningless square and nothing more. … We're therefore interested in what you think and feel about your AI-equipped products, big or small, tangible like a phone or intangible like the famous online service ChatGPT.

Distrust for AI

In addition to trust, there were eight distrust items in the Attitudes Toward AI Scale (Schepman & Rodway, 2020); we also explored their effects. An instant question of the measure is, "I think Artificial Intelligence is dangerous." Here, it might be worth noting that, even though the factors of trust and distrust in AI are superficial antitheses, empirically, they are correlated but separated factors (Schepman & Rodway, 2020). They should therefore be deemed different dimensions but not different ends of the same continuum. As such, we did not make them into one composite in the present study. In practice, the measure followed the same scale and scoring as above; its internal consistency α was 87.

Analysis Strategy

Since the PROCESS Macro (Hayes, 2022) did not support the test of moderation on a five-variable chain mediation (in our case, from the anthropomorphism manipulation to state anthropomorphism to perceived responsiveness to gratitude to trust in AI, with the effect of state anthropomorphism on responsiveness being moderated by received benefit), we broke our hypothesized model down into two pieces, testing one after another. First, we left the final trust in AI out of the scheme, focusing on the cognitive mechanism leading up to gratitude, so we could use the PROCESS Model 91 (for moderated four-variable mediation) on the part of our total model. Subsequently, we turned to the PROCESS Model 6 (for no-moderation five-variable mediation) for the full mediation chain from the anthropomorphism manipulation to trust in AI, but only at the average level of received benefit, by including received benefit and its interaction with state anthropomorphism as covariates in the analysis. Together, the two analyses would combine to paint the whole moderated-mediation model that we put forward.

Results

Benefit Moderation

As planned, we fit a serial mediation model (with indirect effects estimated with 5,000 bias-corrected bootstrapping resamples) from the anthropomorphism manipulation (the nonanthropomorphizing and the anthropomorphizing group were first coded 0 and 1, respectively, and then centered; $N = 381$ for the latter) to state anthropomorphism ($M = -3.52$, $SD = 5.64$), perceived responsiveness ($M = -2.45$, $SD = 6.92$) to each measure of gratitude (for felt gratitude, $M = -0.09$, $SD = 7.35$; for gratitude for technologies, $M = -1.23$, $SD = 7.11$), with the effect of state anthropomorphism on perceived responsiveness being moderated by received benefit (centered; precentering $M = 205.78$, $SD = 157.06$). Bolstering the hypotheses, the results (see Figure 5 for a summary; see Supplemental Materials for full detailed reports) echoed our previous studies and showed that the anthropomorphism manipulation was successful ($\beta = 0.99$, $SE = 0.41$, $df = 758$, $t = 2.43$, $p = .015$), and the main effect of the induced anthropomorphism ($\beta = 0.57$, $SE = 0.03$, $df = 755$, $t = 16.81$, $p < .001$) was trending in being qualified and strengthened by received benefit ($\beta = 4 \times 10^{-4}$, $SE = 2 \times 10^{-2}$, $df = 755$, $t = 1.91$, $p = .056$). Probing deeper, simple-slope tests revealed that when the benefit was low at the 16th percentile (19), the effect of state anthropomorphism was positive but seemingly weaker at 0.49 ($SE = 0.06$, $df = 755$, $t = 8.80$, $p < .001$); on the other hand, the effect became slightly stronger at 0.65 ($SE = 0.05$, $df = 755$, $t = 12.62$, $p < .001$) when the benefit was high at the 84th percentile (411). Finally, such elicited perceived responsiveness predicted both felt gratitude ($\beta = 0.85$, $SE = 0.03$, $df = 756$, $t = 29.62$, $p < .001$) and gratitude for technologies ($\beta = 0.74$, $SE = 0.03$, $df = 756$, $t = 26.77$, $p < .001$). Moderated mediation analyses further corroborated the findings by indicating that the mediation from the anthropomorphism manipulation to gratitude was significantly moderated by received benefit (for felt gratitude, est. $= 3 \times 10^{-4}$, $SE = 2 \times 10^{-4}$, 95% CI [0×10^{-4}, 9×10^{-4}]; for gratitude for technologies, est. $= 3 \times 10^{-4}$, $SE = 2 \times 10^{-4}$, 95% CI [0×10^{-4}, 8×10^{-4}]). When the benefit was low, the mediated effects for felt gratitude and gratitude for technologies were positive but weaker at 0.41 ($SE = 0.17$, 95% CI [0.08, 0.76]) and 0.36 ($SE = 0.15$, 95% CI [0.07, 0.67]), respectively. The effects became stronger at 0.55 ($SE = 0.23$, 95% CI [0.11 1.01]) and 0.48 ($SE = 0.20$, 95% CI [0.09, 0.89]), respectively, when the benefit was high.

Trust in AI

Having tested the moderated-mediation half of our model, we then examined the second, not-moderated serial mediation from

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the anthropomorphism manipulation to state anthropomorphism (centered) to perceived responsiveness to gratitude to trust in AI ($M = 2.87$, $SD = 3.75$) at the average level of received benefit. Practically, we entered (centered) received benefit and its cross-term with (centered) state anthropomorphism in the model as controlled covariates, and the results showed support for the hypotheses. Specifically, we found (see Supplemental Materials for full detailed reports) that the induced gratitude for the computer in our ultimatum game significantly extended into trust in AI (from felt gratitude, $\beta = 0.08$, $SE = 0.03$, $df = 753$, $t = 2.55$, $p = .011$; from gratitude for technologies, $\beta = 0.13$, $SE = 0.03$, $df = 753$, $t = 4.18$, $p < .001$), which subsequently completed the full five-variable mediation from the anthropomorphism manipulation to the trust (through felt gratitude, $\beta = 0.03$, $SE = 0.02$, 95% CI [13×10^{-4}, 0.06]; through gratitude for technologies, $\beta = 0.04$, $SE = 0.02$, 95% CI [44×10^{-4}, 0.08]). Interestingly, we explored distrust in AI, and only observed nonstatistically detectable negative mediation on the distrust (through felt gratitude, $\beta = -0.01$, $SE = 0.02$, 95% CI [−0.05, 0.01]; through gratitude for technologies, $\beta = -0.02$, $SE = 0.01$, 95% CI [−0.05, 0.01]). We again discovered that, by making the computer seem responsive to a person's needs, anthropomorphism engendered gratitude for the machine in the person. More so than previous findings in the current research, we also extracted preliminary evidence that such an effect of anthropomorphism likely took the benefit for the person as a qualifier: The more beneficial the artificial target, the more thanked the object when personified. In addition, this induced gratitude elevated one's trust in AI as anticipated but did not significantly decrease the distrust.

Study 5: Preregistered Conceptual Replication and Extension to Religiosity

Having accumulated evidence in artificial settings, we sought ecological validity in Study 5 (see Figure 6) by focusing on a real-world natural phenomenon as the present nonhuman target of gratitude. We applied the same two-dimensional design as in Study 4. The challenge, however, was that the nonhuman needed to be both authentically beneficial *and* harmful without our pre-programming its influences as in the prior study. As detailed below, we achieved the design with the Kuroshio current.

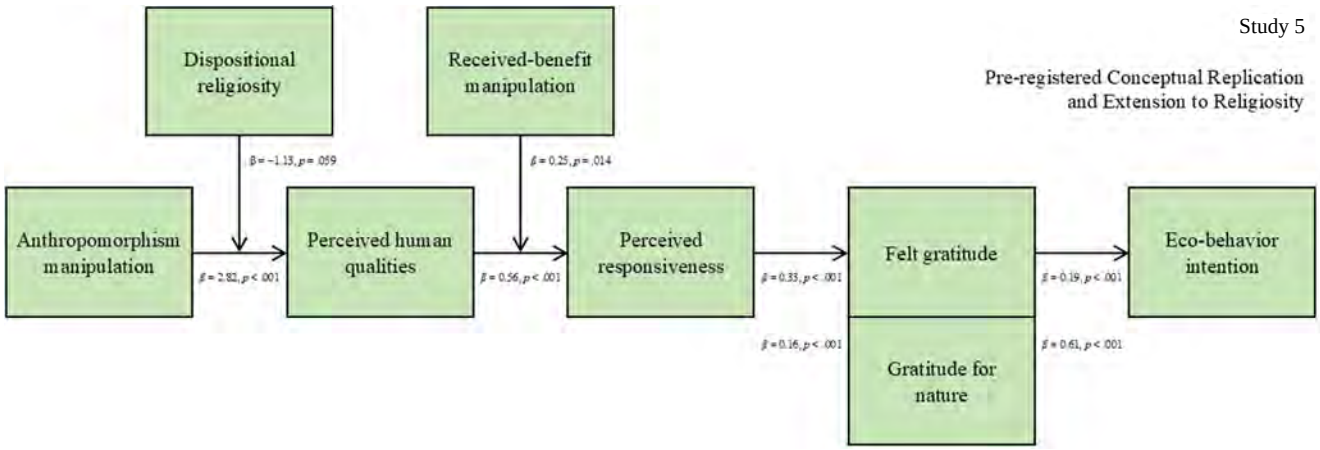
We also considered multiple parallel and lingering supplementary aims. First, the current gratitude candidate would help test the limit of participants' personification capacity: Though likewise natural, waves are not breathing organisms as woods (i.e., Study 3) and therefore potentially more difficult to anthropomorphize. Second, we explored the roles of religiosity because the trait was both an interdisciplinary and ubiquitous special case of anthropomorphism (Guthrie, 1995) and the central construct of the emerging research on gratitude for God (Van Cappellen et al., 2024).

Participants

As preregistered on AsPredicted.org (https://aspredicted.org/fpxx-xdk6.pdf), we aimed to recruit 400 adult U.S. Prolific participants "not really familiar with" (shown on Prolific as a participation requirement) the country of Taiwan, which would render a sensitivity of $f = .16$ (or $|\rho| = .16$; under $\alpha = .05$ and $\beta = 0.20$) in a factorial ANOVA for our two-by-two, anthropomorphism-by-benefit interaction (see Procedure for detail) in the present study when 20% data were removed. After carrying out the planned data cleaning of those who finished the study ($N = 404$) but failed to not slide to the upper/right one-fourth on a slider (labeled *extremely* at the end) when being asked "How familiar are you with the island country of Taiwan?" to slide to the upper/right one-fourth on a slider (labeled *strongly agree* at the end) when being shown the statement of "Five minus two equals three," or to type in more than 10 characters in the writing manipulation ($N = 118$, 29.21%), we retained 286 participants (38.5% women; M of age = 33.78, $SD = 12.91$) as the final sample. To our surprise, this sample size was considerably smaller than anticipated. Upon investigation, we realized the over-exclusion might come from our underestimating how well Americans

Figure 6

Model of Study 5: Preregistered Conceptual Replication and Extension to Religiosity



Note. As in Study 4, Study 5 manipulated both anthropomorphism and the benefit that participants received from a nonhuman, specifically an oceanic current. We then measured the same full downstream psychological process as in Study 3. Preregistered, Study 5 further explored the role of dispositional religiosity in moderating the priming of anthropomorphism. See the online article for the color version of this figure.

knew about Taiwan: 51 individuals (i.e., 43% of the excluded) exceeded the set threshold for overfamiliarity (5). Nonetheless, this data processing was predetermined, potentially critical for the study stimuli to work, and maintained a sensitivity of $f = .17$ (or $|\rho| = .17$) for the focused interaction. We consequently decided to proceed with the sample without deviating from the plan.

Procedure

The experiment applied the same two-dimensional between-participant structure as Study 4 except the manipulation here was a reading-writing task similar to those in Studies 2 and 3. We also included a dispositional religiosity assessment premanipulation. For the manipulation, we chose the Kuroshio current near the island country of Taiwan as the potential benefactor. Even though the current unequivocally profits the local economy, the economy creates an ambiguous international industrial relation with the United States that is deemed competitive in nature by some but complementary and collaborative by others in the United States (Campbell, 2021; Miller, 2022; Toews, 2023). For American participants, the natural entity could hence be introduced as either beneficial, neutral, or harmful, depending on the arguments that we selectively presented to Americans who had not taken a fixed stance on the issue. As in Study 3, the same physicalism (anthropomorphizing) or panpsychism (nonanthropomorphizing) passages then followed and crossed the benefit manipulation to imply, regardless of the current's economic impacts on the United States, the influences were created either mindedly or mindlessly by the ocean, resulting in a two-by-two study factorial design. Specifically, for the high-benefit groups, the manipulation (see Supplemental Material for full detailed stimuli) read as follows:

> Taiwan Semiconductor Manufacturing Company (TSMC) monopolizes 61% of the chip market worldwide. … tech giants of end-user products—Apple, Sony, Tesla, Amazon, Google, Microsoft, AMD, and Nvidia—have been seriously collaborating with this behind-the-scenes TSMC in Taiwan … what most people don't know is that the Kuroshio also plays a key role in the technological achievements of Taiwan and, indirectly, the advances of the U.S., because of a straightforward but commonly overseen reason: the weather. … By providing the water and the stable natural environment, the Kuroshio Current becomes the foundation for the tech industry of Taiwan and, subsequently, facilitates that of America.

In comparison, the counterpart low-benefit prompt read as follows:

> Taiwan Semiconductor Manufacturing Company (TSMC) monopolizes 61% of the chip market worldwide. … tech giants of end-user products—Apple, Sony, Tesla, Amazon, Google, Microsoft, AMD, and Nvidia—have been seriously diverted to this behind-the-scenes TSMC in Taiwan … what most people don't know is that the Kuroshio also plays a key role in the technological achievements of Taiwan and, indirectly, the challenge for the U.S., because of a straightforward but commonly overseen reason: the weather. … By providing the water and the stable natural environment, the Kuroshio Current becomes the foundation for the tech industry of Taiwan and, subsequently, jeopardizes that of America.

Measures

Dispositional Religiosity

As preregistered, we administered the two ideology-aspect items from the 10-item Centrality of Religiosity Scale-10 (Huber & Huber, 2012) premanipulation, to assess individuals' trait religiosity. In the original Centrality of Religiosity Scale-10, there are five aspects of religiosity, namely intellect (e.g., "How interested are you in learning more about religious topics?"), ideology (e.g., "To what extent do you believe that God or something divine exists?"), experience (e.g., "How often do you experience situations in which you have the feeling that God or something divine wants to communicate or to reveal something to you?"), public practice(e.g., "How often do you take part in religious services?"), and private practice (e.g., "How often do you pray?"), each with two items. Here, we included only the ideology part of the Centrality of Religiosity Scale-10 because our objective was merely to investigate how one's preexisting religious understanding of the world—the ideology—affected one's susceptibility to an anthropomorphism induction and then the downstream psychological processes, as opposed to how religion-related personal interests, life histories, or behavioral tendencies would do the same. Specifically, participants rated the selected questions on a 5-point Likert-type scale with points 1 to 5 labeled *none at all*, *a little*, *a moderate amount*, *a lot*, and *a great deal*, respectively. The average of the two items was calculated as the index; their internal consistency α was .76.

Anthropomorphism

Same as in Studies 2 and 4. Here, the scale's internal consistency α was .95.

Gratitude for Nonhumans

Felt Gratitude. Same as in Studies 2 and 3, except for "the Kuroshio Current."

Gratitude for Nature. Same as in Study 3, except on a negative-10-to-positive-10 slider where the two ends were labeled *strongly disagree* and *strongly agree*, respectively. The internal consistency α here was .93.

Perceived Responsiveness

Same as in Studies 2 and 3, except sharing the new prompt with the measure of felt gratitude.

Intention for Ecobehavior

Same as in Study 3, except again on a negative-10-to-positive-10 slider where the two ends were labeled *strongly disagree* and *strongly agree*, respectively. The measure's internal consistency α was .90.

Analysis Strategy

We preregistered and administered the same analytic plan as in Study 4 to test our main hypotheses in the current experiment. Specifically, we first fit a serial mediation model (with indirect effects estimated with 5,000 bias-corrected bootstrapping resamples) from the anthropomorphism manipulation (the nonanthropomorphizing and the anthropomorphizing group were first coded 0 and 1, respectively, and then centered; $N = 145$ for the latter) to state anthropomorphism ($M = -0.18$, $SD = 6.08$) to perceived responsiveness ($M = 2.67$, $SD = 6.32$), to each measure of gratitude (for felt gratitude, $M = 5.25$, $SD = 4.54$; for gratitude for

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nature, $M = 6.31$, $SD = 3.17$), with the effect of state anthropomorphism on perceived responsiveness being moderated by the benefit moderation (center; before centering, the low and the high-benefit groups were coded 0 and 1 respectively; $N = 150$ for the latter). Having tested the moderated-mediation half of our model, we then followed the same strategy again as in Study 4 to examine the second, not-moderated serial mediation from the anthropomorphism manipulation to the intention for ecobehavior ($M = 4.93$, $SD = 3.46$) at the average level of benefit. Finally, we included in the preregistration an exploration of the potential moderation of religiosity on the effect of the anthropomorphism manipulation, that is, on state anthropomorphism.

Results

Benefit Moderation

Bolstering the hypotheses, the results (see Figure 6 for a summary; see Supplemental Materials for full detailed reports) echoed all our previous studies and showed that the anthropomorphism manipulation was successful ($\beta = 2.82$, $SE = 0.70$, $df = 284$, $t = 4.03$, $p < .001$), and the benefit manipulation ($\beta = 0.25$, $SE = 0.10$, $df = 281$, $t = 2.46$, $p = .014$) significantly qualified and strengthened the main effect of the induced anthropomorphism ($\beta = 0.56$, $SE = 0.05$, $df = 281$, $t = 10.59$, $p < .001$) Simple-slope tests revealed that, for the low-benefit groups, the effect of state anthropomorphism was positive but weaker at 0.43 ($SE = 0.08$, $df = 281$, $t = 5.64$, $p < .001$), but the effect became stronger at 0.68 ($SE = 0.07$, $df = 281$, $t = 9.44$, $p < .001$) for the high-benefit groups. Finally, such elicited perceived responsiveness predicted both felt gratitude ($\beta = 0.33$, $SE = 0.04$, $df = 282$, $t = 7.55$, $p < .001$) and gratitude for nature ($\beta = 0.16$, $SE = 0.03$, $df = 282$, $t = 4.98$, $p < .001$). Moderated mediation analyses further corroborated the findings by indicating that the mediation from the anthropomorphism manipulation to gratitude was significantly moderated by the benefit moderation (for felt gratitude, est. = 0.23, $SE = 0.12$, 95% CI [0.02, 0.51]; for gratitude for nature, est. = 0.12, $SE = 0.07$, 95% CI [0.01, 0.27]). When the benefit was low, the mediated effects for felt gratitude and gratitude for nature were positive but weaker at 0.40 ($SE = 0.16$, 95% CI [0.15, 0.76]) and 0.19 ($SE = 0.08$, 95% CI [0.06, 0.39]) respectively, but the effects became stronger at 0.63 ($SE = 0.20$, 95% CI [0.28 1.09]) and 0.31 ($SE = 0.12$, 95% CI [0.11, 0.58]) respectively when the benefit was high.

Intention for Ecobehavior

Analogous to our previous results, the analysis showed (see Supplemental Materials for full detailed reports) that the induced gratitude for the Kuroshio significantly extended into the intention (from felt gratitude, $\beta = 0.19$, $SE = 0.05$, $df = 279$, $t = 4.02$, $p < .001$; from gratitude for nature, $\beta = 0.61$, $SE = 0.05$, $df = 279$, $t = 11.45$, $p < .001$), which subsequently completed the full five-variable mediation from the anthropomorphism manipulation to the intention for ecobehavior (through felt gratitude, $\beta = 0.10$, $SE = 0.05$, 95% CI [0.03, 0.21]; through gratitude for nature, $\beta = 0.16$, $SE = 0.06$, 95% CI [0.06, 0.29]). We again documented that anthropomorphism made the participants feel thankful for nonhuman targets—here, a natural one—by producing perceived responsiveness in the entities. Solidifying the results in Study 4, we further reported evidence that such an effect of anthropomorphism used the profits for the person as a qualifier: The thanks needed to be for something beneficial. Finally and similarly, this induced gratitude improved the participants' plans for taking proenvironmental actions in the near future.

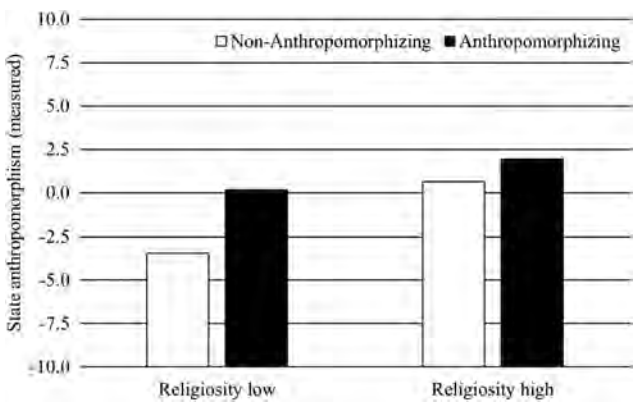
Religiosity Moderation

As planned, we investigated the potential moderation effect of religiosity on the efficacy of the anthropomorphism manipulation—the manipulation's strength in inducing state anthropomorphism. The results (see Supplemental Materials for full detailed reports) indicated that dispositional religiosity ($M = 3.38$, $SD = 1.13$) positively predicted the state anthropomorphism ($\beta = 1.43$, $SE = 0.30$, $df = 282$, $t = 4.78$, $p < .001$) and was trending to negatively moderate—that is, dampen—the effect of the anthropomorphism manipulation ($\beta = -1.13$, $SE = 0.60$, $df = 282$, $t = -1.89$, $p = .059$). Simple-slope analyses further indicated that the overall successful anthropomorphism induction reported above was statistically nullified and became undetectable when one held strong (at 4.50, the 84th percentile) religiosity ($\beta = 1.30$, $SE = 0.95$, $df = 282$, $t = 1.38$, $p = .170$).

In other words, all the above findings combined would suggest that, as visualized in Figure 7, religiosity could keep the participants' personification tendencies activated and insulated from being turned off by external influences such as our manipulation. As a potential result, with anthropomorphism now being a constant default, the faithful would only need to look out for benefit, not the intention behind it, before translating the benefit into the environment's responsiveness toward themselves. Probing this logical inference (beyond the preregistration), we subsequently conducted a three-way interaction model wherein the two-way interaction between both experimental manipulations on perceived responsiveness was qualified by religiosity. Bolstering our conjecture, the results showed that religiosity was trending in negatively moderating the cross-term of the manipulations ($\beta = -2.33$, $SE = 1.26$, $df = 278$, $t = -1.85$, $p = .065$), seemingly making benefit less dependent on the artificial anthropomorphism induction in eliciting a perception of the ocean being an understanding, validating, and caring partner.

Figure 7

Moderating Role of Religiosity in Anthropomorphism Induction



Note. The anthropomorphism manipulation was nullified and became ineffective when dispositional religiosity was high.

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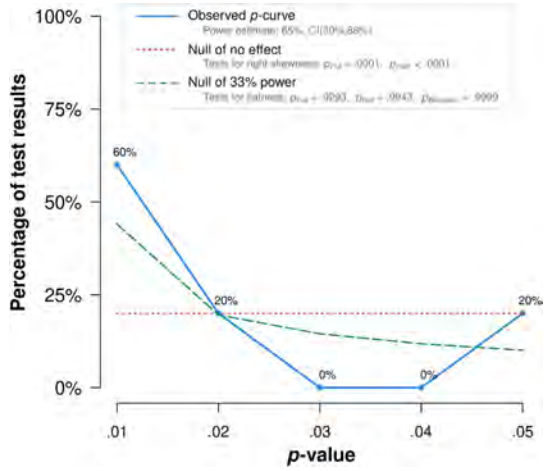
Replicability Test

Since not all studies in the research were preregistered, we conducted a *p*-curve analysis[1] (Simonsohn et al., 2014a, 2014b, 2015) across them to examine the replicability of the phenomenon of anthropomorphized gratitude. Technically, we only included the effects (see Supplemental Materials for the detailed list of the effects) of anthropomorphism on gratitude (cf. those on responsiveness, ecobehavior, trust in AI, or the benefit moderation) in the test, for they were the theoretical focus and the empirical through line of our work. To construct not only a reasonable but indeed the most conservative analysis, whenever possible, we only selected the hypothesized effects of the anthropomorphism manipulation on all gratitude measures at the high-benefit condition, without control covariates, through and only through the theorized mediators. Because the bootstrapping method provided the nonparametric confidence intervals without a parameter estimate, the *t*-scores of mediation findings were subsequently calculated by plugging the bootstrapping coefficients and standard errors into the standard *t*-score formula. Here, different from their significant bootstrapping estimates, two of the results in Study 2 came out trending but not significant in the predicted direction in the parametric framework (*t*s = 1.91 and 1.92, so *p*s = .057 and .056 for felt gratitude and gratitude for technologies respectively). We hence replaced the two's *t*s with $t = 1.97$, that is, $p = .050$ in the following analysis. In so doing, the effects would be counted (the *p*-curve excludes nonsignificant results) and *decrease* the evidential value of the research; with a $p = .050$, the two would bear the least possible evidential value any effect could show for a *p*-curve and then compromise the value of other, stronger findings.

Having adjusted the *p*-curve replicability test in these conservative ways, we still found the data documented over the research to serve as substantial evidence for the impact of anthropomorphism on gratitude. In particular, both full and half *p*-curves (see Figure 8) were significantly right-skewed ($Z = -3.67$ with $p < .001$ and $Z = -4.48$ with $p < .001$, respectively) and not significantly flatter than the 33% power line ($Z = 1.47$ with $p = .929$ and $Z = 2.53$ with $p = .994$, respectively). It was also discovered that we would need to remove not one but two of the strongest results to make the total evidence appear equivocally supportive (i.e., potentially cherry-picked despite being significant in the favored direction). Consequently, we concluded that the current research as a whole established the proposal that, given a benefit, anthropomorphism leads to the emotion of gratitude for nonhuman objects. Our evidence did not hinge on potential, omitted studies in the file drawer, nor did it depend on a single outlying large finding driving the conclusion.

Figure 8

p-Curve of the Present Research



Note. The effects entered in the *p*-curve analysis produced a significantly right-skewed *p*-curve (against the red, nonskewed line), indicating evidential value in the set of results. The analysis also showed that the research package as a whole bore adequate observed post hoc power, for being not significantly wider and actually steeper than the low-power threshold (the green line). CI = confidence interval. See the online article for the color version of this figure.

General Discussion

> Mankind must reconsider the anthropocentric, egocentric position it has taken hitherto, and situate itself in the great movement of the cosmos, in the eternal cyclical movement of all life.[2]
>
> —Takeshi Umehara, Japanese Philosopher, 1920–2019

Expanding the latest theory of gratitude for humans (Algoe, 2012) to nonhuman targets, we argue that an individual experiences gratitude for nonhuman entities when the person anthropomorphizes the targets and attributes received benefits to the objects' perceived responsiveness. Accordingly, the grateful perceiver will provide care for the nonhuman entities as the former do for real humans. Five empirical studies support these hypotheses. In particular, we show that both trait and state anthropomorphism lead individuals to view natural and artificial nonhumans as responsive partners. The effect strengthens when individuals benefit in the process; nevertheless, gratitude for nonhumans still appears to a lesser degree when the benefits are low (e.g., in the low- and the no-benefit conditions in Studies 4 and 5, respectively). Such perception of responsiveness subsequently induces thankful feelings toward nonhuman targets, engendering a trusting attitude and a protective urge. Finally, we demonstrate that these findings are statistically replicable and do not merely result from the possibility that the possession of a mind is a desirable quality. Qualities that are similarly valued but not reserved for humans do not explain away the findings.

Altogether, our research suggests that gratitude for objective nonhumans is, essentially, gratitude for subjective humans. Through thanks, humans bond with nonhumans as they do with each other. This phenomenon covers natural (e.g., the environment, Tam, 2022; God, Van Cappellen et al., 2024) and artificial nonhumans (as we show). Critically, this theory for nonhumans explains human

[1] We did not rely on an internal meta-analysis because, despite the unwarranted common belief, the method provides little examination against cherry-picking findings (Vosgerau et al., 2019). When all reported results are significant as in the present research, their aggregate meta-analytic effect is destined to be significant and seemingly supportive (as in our case, the meta-analytic effect size $r = .17$, $SE = .03$, $df = 9$, $t = 6.29$, $p = < .001$, 95% CI [.11, .23]), even if the findings are selectively included. By contrast, what may be helpful in a meta-analytic process is the optional funnel-plot test: When the plot comes out asymmetric, it serves as the indication some effects are picked "out." For the test, our funnel plot was not found asymmetric ($Z = 0.46$, $p = .646$), corroborating the result of the *p*-curve analysis.

[2] From *The Japanese View of the "Other World": Japanese Religion in World Perspective* (Umehara, 1991)

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interactions, too, because it relies on a human(nized) psychological process. Consequently, the research aligns with Tsang et al.'s (2022) hypothesis that gratitude for *the intangible* is a result of recognizing the intangible's high-construal-level benevolence rather than the low-level benefits it provides. Broadening the proposal, our work implies that Tsang and colleagues' idea may underlie gratitude for all beings: tangible, intangible, human, and nonhuman.

Implications

What Is Gratitude?

Now that the target of gratitude does not require a physical body, our findings suggest that, functionally, gratitude may be more of a detector for benevolence than for benefactors (Algoe, 2012) or benefits (McCullough et al., 2008). This updated account may help integrate the few major nonemotional approaches to gratitude: the moral (McCullough et al., 2001), the dispositional (Watkins & Bell, 2017), and the interventional (Davis et al., 2016). To begin with, scholars propose that gratitude carries ethical significance because it results from prosocial deeds (e.g., receiving benefits) and in prosocial deeds (e.g., reciprocating benefits; McCullough et al., 2001). Yet, prosociality per se guarantees no morality; the actor can be forced into the action or create the outcome by accident without any willful intent. Studies have indeed discovered that an action appears moral for its perceiver not because of its beneficial, material outcomes but because of the perceived intentional agency that propels the action (K. Gray et al., 2012). Vindicating gratitude and integrating it into the literature, our results indicate that the emotion reflects benevolence instead of the benefit it generates. As such, gratitude *is* morally informative, perhaps more so than previously believed.

Likewise, because humanity lies in the eyes of the beholder, gratitude may be a matter of subjective perception as demonstrated across our most extreme, nonhuman instances. A potential consequence is that the emotional state may depend substantially on the perceiver's characteristics, which manifests itself as a dispositional trait in daily life (Watkins & Bell, 2017). Nevertheless, note that existing theories on gratitude as an emotional state, most notably those by McCullough et al. (2008) and Algoe (2012), may agree with this dispositional implication. In their research, McCullough et al. (2002) have documented those who are consistently "predisposed" to experiencing thankful feelings, although such predisposition remains unexplained. Algoe, structuring her theory around subjectively *perceived* responsiveness (Reis & Gable, 2015), may also accept that the objective physical environment is not the only source of gratitude. Something subjective and psychological also affects if and how individuals perceive and experience their partners in a routine pattern. Connecting these lines of literature, our findings imply that one's propensity to sense intentionality in the world—trait anthropomorphism—may serve as the foundation for representative discoveries in the literature: Algoe et al.'s (2013) observation that responsive intentions forecast the mutual care between romantic partners, Watkins and Bell's (2017) finding that a belief in divine intentions predicts an appreciative personality (Watkins et al., 2003), and McCullough et al. report that similar religiosity correlates with a grateful predisposition (McCullough et al., 2002). We, too, show that religiosity seemingly keeps an individual's anthropomorphism strong and protected from momentary deactivators.

Last, our article sheds light on how *personal* well-being interventions effectively cultivate *interpersonal* experiences of gratitude (as reviewed by Davis et al., 2016). Following the same line of reasoning, we suspect that existing interventions succeed when they train those in the interventions to develop a dispositional inclination to personify their surroundings. Once installed, this tendency may amplify the trainees' grateful reactivity to the benefits they receive, as observed in our studies. Accordingly, we expect gratitude practices that highlight seeing good-*will* in the social or physical environment to demonstrate better efficacy than gratitude practices emphasizing finding *good*-will. Because felt gratitude is itself a positive affect and therefore a defining component of subjective well-being, the capability and tendency to see relatable and responsive other minds in life should contribute to personal well-being when engendering gratitude. Focusing on the generous intentionality of humanized others should further enhance the relational well-being of a thankful person when this thankful beneficiary reciprocates to the benefactor and the thanked benefactor reciprocates in return (Algoe et al., 2016; Park et al., 2020).

What Is Relationship?

As with the emotion of gratitude, our research challenges the existing conceptualization of relations built by gratitude and more. Analyzing imaginary relationships with impossible nonhuman targets, among which some hardly have tangible forms, our work indicates that relationships do not need to be interpersonal. Instead, bonding is most likely intrapersonal—constructed by and confined in the mind. This relational idealism, however, may liberate humans from their physical bodies, as they can now befriend everything everywhere in every moment. In line with the proposal, studies have found that individuals ubiquitously feel parasocially connected with and loved by many *things*. These range from celebrities (Hoffner & Bond, 2022) and fictional characters (Rain & Mar, 2021) to one's past and future self (Sedikides et al., 2023) to robots and AI (Guerreiro & Loureiro, 2023) to deities and mystical beings (White et al., 2024) to pets (Amiot & Bastian, 2015) to nature (Jacobs & McConnell, 2024) to consumer brands (Shimul, 2022) to nostalgic places (Diener & Hagen, 2022). These nonhumans can all appear to bear personhood, but their personhood only interacts with real, existing humans through the human minds, even if some pseudo-persons were once living persons and some still are. Relationships with nonhumans indeed exist.

Accordingly, we may ask what mutual care in relationships means. Our stance is that reciprocation should be defined subjectively but not objectively as emotion and relation. Care providers—the expressers of thanks in our case—must decide for themselves what they think care recipients—the targets of thanks—would like to receive and dynamically adjust through an intersubjective (Cortina & Liotti, 2010) process. Supporting this prediction, research has found that the subjective perception of the partner being responsive and therefore presumably appreciable (Algoe & Chandler, 2024) increases the perceiver's willingness to sacrifice for what the partner wants (Visserman et al., 2022). In addition, recipients of gratitude identify thankful messages—for example, in sacrifices—more easily through gratitude expressions that fit with the recipients' cultural conventions. (Chang & Algoe, 2020) In other words, humans care for each other by first subjectively conjecturing the wishes of care recipients, who in turn understand the care by similarly assuming an interpretive context.

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For applications, we consequently infer that our participants planned for their care of the environment based on a naïve theory that nature would benefit from the specific care chosen. Future investigations may explore this lay ecopsychology and examine whether the same cognitive scheme applies to other nonhuman entities. The work may stimulate real-world designs that facilitate human practices toward their surroundings, animate or inanimate.

Constraints on Generality and Future Directions

The current research conceptualizes perceived humanity as a unified construct, partly due to the findings of our (Study 1) and past (Tzelios et al., 2022) studies that its theoretical manifestations mostly covary under one single empirical dimension. Yet we acknowledge that theorists have been examining the possibility of breaking mind perception into subdomains (H. M. Gray et al., 2007; Weisman et al., 2017). For example, H. M. Gray et al. (2007) suggested that perceived mind differs along the experience-input and the agency-output capacities. For the two mind dimensions, we suspect that gratitude for nonhumans requires the anthropomorphization of both. Thanking an outputting (gifting) benefactor who seems incapable of inputting (receiving) thanks appears futile and therefore evolutionarily unsustainable. This conjecture may also explain why anthropomorphism emerged as unidimensional in our study. Regardless, it is an empirical question as to how the dimensionality of personification affects gratitude for nonhuman objects, which we invite future work to tackle.

Our study designs also had limitations. First, our studies employed a series of customized methodologies, ranging from task prompts (e.g., the "things-you-interacted-with" paradigm in Study 1) to measures (e.g., Gratitude for Technologies in Study 2) to manipulations (e.g., the game with the computer in Study 4). Although we adapted all the methods from the literature, the adaptations need more rigorous validation in the future. In addition, we document that personification promotes plans for reciprocation for the appreciated nonhumans, but intentions rarely guarantee actions (Gollwitzer & Sheeran, 2025; Granados Samayoa & Albarracín, 2025). The correspondence between both sides, though not zero, is unstable, fragile, and as such a challenge in the literature in and of itself. (Granados Samayoa & Albarracín, 2025) Here, the field has recognized that closing the behavior–intention gap involves sophisticated techniques beyond simple motives (Gollwitzer & Sheeran, 2025). Future investigations should therefore study not only *if* but also *how* an individual realizes their intent to repay different types of nonhumans after the individual has felt grateful for the targets.

Moreover, although online studies (Casler et al., 2013) are already less WEIRD (western, educated, industrialized, rich, democratic; Henrich et al., 2010), we still limited the data to U.S. residents because the sample would otherwise be neither homogenous and local nor representative and global. Follow-up work should address cultural influences on anthropomorphized gratitude. Regarding the issue, the literature has shown that different cultures find different nonhuman entities useful (Atari et al., 2022; Talhelm et al., 2014). In contrast, emphasizing human goodwill, even if manifested differently, appears culturally common: The budding work has indicated that individuals recognize others' *uniquely* cultural expressions of thanks exactly because the behaviors would seem *similarly* responsive in context (Chang & Algoe, 2020). For nonhuman targets, cultures worldwide commonly seem to perceive "faces in clouds and voices in winds" in one way or another: Supernatural personification is a universal and ancient phenomenon. (Guthrie & Porubanova, 2024) We consequently believe that culture might be less about the theoretical weight of anthropomorphism, but more about the kinds of nonhumans that are deemed beneficial in their cultural contexts and therefore appreciable once anthropomorphized.

Highlighting benefits as a matter of perception, this prediction concerning culture also points out another limitation in our studies: We cannot be certain how the objectively presented benefits and harms were subjectively received. Nonetheless, the discrepancy may help explain individuals' feelings of gratitude in some seemingly impossible circumstances (e.g., in domestic violence cases where the victims believe the abuses are out of care; Pocock et al., 2020). Take our Study 5. It told participants in the low-benefit condition that they were not merely less benefited (e.g., as their counterparts in Study 4) but indeed harmed. Yet they still reported some (albeit less, as hypothesized) appreciation for the harmful oceanic current. For this counterintuitive finding, a possibility other than the measures being invalid is that the nonhuman was not simply deemed bad while creating the harm, but merely less good. Supporting such a potential perceptual twist, Levine et al. (2018) have demonstrated that, even though enacted harms and benefits imply the actors' bad and good intentions, respectively, recipients of the actions do not base their judgment of the actors solely on the treatments received. Instead, both adults and children begin with a *good intention prior*, assuming some initial benevolence in others. Only when that subjective prior is fully canceled out by sufficient objective harm will the wrongdoers appear more evil than neutral. In addition, research on perceived naturalness has found that people commonly irrationally find natural entities superior—relatively safe, beautiful, and useful—to their artificial counterparts (Meier et al., 2026). Together, the lines of work suggest that the objective harm described in our study might not be subjectively harmful enough. Future investigations would hence want to explore the extreme by closing this perceptual gap.

Finally, future research may scrutinize the distinction between gratitude and indebtedness. Both emotions arise when one receives tangible or intangible gifts from others, but gratitude is positive and enjoyable, whereas indebtedness is negative and unpleasant (e.g., shameful; Watkins et al., 2006). At the same time, individuals in cultures lower in autonomy seeking (e.g., Korea, compared to the United States) tend to experience the dark, indebted side of beneficial social exchanges more than the bright, grateful side (Oishi et al., 2019; Vishkin et al., 2025). Taken together, these findings support our proposal that gratitude stems from perceiving autonomous goodwill: Where there is no beneficence in benefits, there is but indebtedness. Research has also found that the negative emotion of indebtedness emerges most pronouncedly when benefactors communicate their anticipations for payback and that they act kindly for their ultimate self-interest (Watkins et al., 2006). Crucially, the gift-givers are not the only ones lacking intentionality for another person's welfare here; the indebted beneficiaries would also sense a loss of status and freedom to their creditors (Greenberg, 1980). These beneficiaries would therefore reciprocate not to promote their benefectors' well-being but to clear their own debts (Peng et al., 2018). As such, future investigations may want to examine if a lack of other-focused benevolence on both sides of the beneficial social-exchange relationship turns gratitude into indebtedness.

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