**Revisiting the positive association between loneliness and anthropomorphism with an extension to belief in free will: Replication and extensions of Epley et al. (2008)**

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## Author Contribution

H.Y.C., M.C.T., T.H.W., and Y.W. developed the study concept and wrote the initial draft under the supervision of Q.X. and G.F. M.E., C.P., and Q.X. finalized the Stage 1 submission and G.F. made critical revisions. M.E., C.P., Q.X., and G.F. will perform pre-registration, data collection, formal analysis, and write the final report. G.F. acquired funding and resources and will administer the project and curate the data.

**Declaration of Conflict of Interest**

The author(s) declared no potential conflicts of interests with respect to the authorship and/orpublication of this article.

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## Contributor Roles Taxonomy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Role** | **M.E.** | **C.P.** | **Q.X.** | **H.Y.C., M.C.T., T.H.W., & Y.W.** | **G.F.** |
| Conceptualization |  |  |  | X | X |
| Pre-registration | X | X | X | X |  |
| Data curation |  |  |  |  | X |
| Formal analysis | X | X | X |  |  |
| Funding acquisition |  |  |  |  | X |
| Investigation | X | X | X | X |  |
| Pre-registration peer review / verification | X | X | X |  | X |
| Data analysis peer review / verification | X | X | X | X |  |
| Methodology | X | X | X | X |  |
| Project administration |  |  |  |  | X |
| Resources |  |  |  |  | X |
| Supervision |  |  | X |  | X |
| Validation | X | X | X |  | X |
| Visualization | X | X | X |  |  |
| Writing – original draft | X | X | X |  |  |
| Writing – review and editing | X | X | X |  | X |

**Stage 1 Snapshot**

**Provisional title.**

Revisiting the link between anthropomorphism and loneliness with an extension to free will belief: Replication and extensions of Epley et al. (2008)

**Authors and affiliations.**

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**Field and keywords.**

Field: social psychology; Keywords: anthropomorphism; loneliness; free will belief; registered report; replication

**‎Research question(s) and/or theory.**

We are planning a replication and extension of Studies 1-3 in Epley et al. (2008) and will follow their theory on the positive link between loneliness and anthropomorphism (attributing human behavioral characteristics and mental states to non-humans). The three studies are combined into a single design, with the dependent variables of the different studies displayed in random order. We aim to revisit all studies in this article given the inconsistent and mixed findings so far in replication attempts of specific studies from this article (Bartz et al., 2016; Open Science Collaboration, 2015). Our extensions examine links between anthropomorphism, free will beliefs, and controllability.

**Hypotheses.**

Our replication of Epley et al. (2008) will follow their hypotheses: loneliness is positively associated with anthropomorphism, specifically with anthropomorphic ratings of gadgets (Study 1 replication), pets (Study 2 replication), and supernatural beings (Study 3 replication).

Our extension hypotheses are that free will beliefs are associated with anthropomorphism (similar to the above, competing hypotheses for positive or negative associations) and that the two predictors have unique predictive power (association holds for each of those factors even when controlling for the other factor).

**Study design and methods.**

This is a correlational study design. Two predictor variables: (1) loneliness, measured with the UCLA Loneliness Scale, and (2) belief in free will, assessed with the five-item Free Will Subscale from the Free Will Inventory. The dependent variables are anthropomorphism of four categories: (1) technological gadgets (from the original Study 1), (2) belief in supernatural beings (from the original Study 2), (3) anthropomorphism of supernatural beings (our extension), and (4) anthropomorphism of pets (from the original Study 3).

Participants will be recruited online on Amazon Mechanical Turk using CloudResearch, employing best practices, tools, and survey design for ensuring comprehension, attentiveness, and high-quality data collection in labor markets. We aim to determine sample size with a power analysis (95%, 0.05) of a conservative estimate of original’s findings of the weakest effect.

**Key analyses that will test the hypotheses and/or answer the research question(s).**

In the replication we follow the data analysis conducted in the original article. To test the main hypotheses regarding the effects of loneliness and the target anthropomorphism (gadgets, pets, supernatural beings), we conduct a series of correlational analyses and regression models (for controlling factors) between loneliness and anthropomorphism of gadgets. For the extensions, we conduct similar correlational analyses between free will beliefs and all dependent variables measuring anthropomorphism.

**‎Conclusions that will be drawn given different results.**

We evaluate the replication results using the criteria set by LeBel et al. (2019) based on whether the effects are consistent and there is a signal in the expected direction. Findings regarding the extension can direct new research directions about the links between free will, controllability, and anthropomorphism.

**Key references.**

Epley et al. (2008). https://doi.org/10.1111/j.1467-9280.2008.02056.x

Bartz et al. (2016). https://doi.org/10.1177/0956797616668510

Open Science Collaboration (2015). https://doi.org/10.1126/science.aac4716

# Abstract

IMPORTANT: This is a Registered Report Stage 1 before data collection. Written in past tense as a template to simulate what the final manuscript will look like. No pre-registration or data collection have been conducted.

Human beings have a fundamental need to connect with others. Epley, Akalis, et al. (2008) found that people higher in chronic loneliness had a stronger tendency to anthropomorphize non-human objects, presumably for fulfilling unmet needs for social connection. We conducted a close replication of Epley, Akalis, et al. (2008): Based on the setup of their Study 1, we examined the correlations between loneliness and anthropomorphism of technological gadgets (original Study 1) and pets (original Study 3) and belief in supernatural beings (original Study 2), with a large U.S. sample recruited from MTurk (*n* = [XX; target *n* is 1,000]). Meanwhile, we extended the replication by examining the association between belief in free will and anthropomorphism. We found [weak-to-no / weak / medium / strong] empirical support for the original conclusion / our extensions. […]. All materials, data, and code are available on <https://osf.io/2sb7x/>.

*Keywords*: anthropomorphism; loneliness; free will belief; replication; Registered Report

# PCI-RR Study Design Table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Question | Hypothesis | Sampling plan | Analysis Plan | Rationale for deciding the sensitivity of the test for confirming or disconfirming the hypothesis | Interpretation given different outcomes | Theory that could be shown wrong by the outcomes |
| What is the relationship between loneliness and anthropomorphism? | Loneliness is positively associated with anthropomorphism (because higher loneliness implies stronger sociality motivation). | We conducted *a priori* power analysis based on existing effect size estimates. We further enlarged this sample size given our budget. The final sample size is over 2 times the required sample size suggested by our power analysis (assuming a power of .95 for detecting existing effect sizes in the literature). | Pearson correlation (loneliness/free will belief and each of the anthropomorphism measures) | Based on effect sizes reported in previous, conceptually similar studies | If we fail to find a positive relationship between loneliness and anthropomorphism, it could be because: (1) the three-factor theory does not apply in this study context; (2) the anthropomorphism measure(s) are not valid; (3) the sample size is not large enough (the true effect size is too small). | Three-factor theory of anthropomorphism (Epley et al., 2007) |
| What is the relationship between free will belief and anthropomorphism? | Free will belief is associated with anthropomorphism (but we don’t know in which direction). | This is an extension. As such, we don’t have a sampling plan for testing this hypothesis. | N/A | An association in either direction is possible given the literature and our reasoning (see manuscript for details). | N/A |
| What is the relationship between perceived controllability of non-human objects and anthropomorphism of them? | Perceived controllability is negatively associated with anthropomorphism (because the former is positively associated with effectance motivation). | This is an extension. As such, we don’t have a sampling plan for testing this hypothesis. | Linear mixed-effects models (predicting anthropomorphism with perceived controllability and covariates) | N/A | Same as in Q1 | Three-factor theory of anthropomorphism (Epley et al., 2007) |

**Revisiting the positive association between loneliness and anthropomorphism with an extension to belief in free will: Replication and extensions of Epley et al. (2008)**

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Human beings have a fundamental need for social connection (Baumeister & Leary, 1995), and this need motivates people to socialize when they feel lonely. Yet, very often, one has no immediately available others to connect with. At such times, it has been proposed that people *anthropomorphize* their surroundings (i.e., attributing the behavioral characteristics and mental states of humans to non-human objects) as an alternative way to satisfy their sociality need (Epley, Akalis, et al., 2008; Epley, Waytz, et al., 2008; Epley et al., 2007). In this research, we examined the positive association between anthropomorphism and sociality motivation (as proxied by level of chronic loneliness) through replicating Epley, Akalis, et al. (2008), one of the first empirical investigations providing evidence for this association. In the following, we briefly introduce the theoretical background of the sociality motivation-anthropomorphism association, outline our motivation for conducting this replication, and present an overview of our replication study as well as our extensions to it.

## Three-factor theory of anthropomorphism

The most influential account of anthropomorphism as a psychological phenomenon is the three-factor theory (Epley et al., 2007). It suggests that people anthropomorphize a non-human target (1) when it elicits accessible knowledge about human beings (e.g., when the target has a human-like “face”), (2) when motivated to understand, explain, predict, and control their surroundings, and (3) when motivated to establish social connections and affiliations. In other words, *elicited agent knowledge*, *effectance motivation* (White, 1959), and *sociality motivation* are three key determinants of people’s anthropomorphic tendency. These determinants can affect anthropomorphism via dispositional, situational, developmental, and cultural factors. For instance, individual differences in chronic loneliness, which is a dispositional variable, was found to be positively associated with anthropomorphic tendency (Epley, Akalis, et al., 2008, Study 1; Epley, Waytz, et al., 2008, Study 1). Temporarily induced social disconnection—a situational variable—can also increase anthropomorphism (Epley, Akalis, et al., 2008, Studies 2 and 3). Because both chronic loneliness and temporary social disconnection create a sociality motivation, they both increase anthropomorphism, and via the same determinant.

## Replication target and motivation for replication

In this research, we attempted to replicate Epley, Akalis, et al. (2008). Study 1 of the article measured participants’ anthropomorphism (i.e., the extent to which targets have “a mind of its own,” “intentions,” “consciousness,” etc.) toward a series of technological gadgets, several non-anthropomorphic ratings of the gadgets (e.g., attractiveness), and their chronic loneliness levels (with a short 3-item scale from Hughes et al., 2004). The study found that anthropomorphism and loneliness were positively correlated after non-anthropomorphic ratings were controlled for. Study 2 used an experimental approach and manipulated social connection by suggesting to participants that they would either end up lonely in their lives or be strongly socially connected, ostensibly based on their responses to a personality questionnaire (Twenge et al., 2001). It was found that those induced to feel socially disconnected had stronger beliefs in supernatural agents (e.g., God, ghosts), regardless of their baseline levels of religiosity. Finally, Study 3 induced socially disconnected, fearful, or neutral (as a control) feelings in participants by having them watch emotionally laden video clips. Participants then reported their beliefs in supernatural agents (like in Study 2), chose adjectives that best described their pets from a given list, and noted down what they saw from a series of ambiguous figures. It was found that participants in the social disconnection condition reported higher beliefs in supernatural beings and chose more anthropomorphic adjectives (e.g., thoughtful, considerate) than those in the fear and control conditions. In contrast, participants in the fear condition detected more faces from ambiguous figures than those in the other two conditions. According to the authors, this finding illustrated that the observed anthropomorphism effects were “not simply produced by any negative emotional state,” but specifically by a feeling of loneliness, or social disconnection (Epley, Akalis, et al., 2008). Overall, their results supported the idea that sociality motivation increases anthropomorphism.

Later studies have largely corroborated these findings. Both self-rated and temporarily induced loneliness were found to be positively associated with anthropomorphizing a wide range of non-human targets, including smartphones, computers, animals, and robots (Eyssel & Reich, 2013; Shin & Kim, 2020; Wang, 2017), and preferences for anthropomorphized targets, such as consumer product brands (Chen et al., 2017). There is also preliminary evidence suggesting that a lack of social connection may account for particularly strong anthropomorphic tendencies in people with autistic traits (Caruana et al., 2021) and hoarding behaviors (Burgess et al., 2018; Neave et al., 2015).

Despite this body of evidence, we decided to replicate Epley, Akalis, et al. (2008) for three reasons: (1) the article has had a high impact in the field of social perception (over 700 citations as of November 2022), (2) the studies had relatively small sample sizes (total *N* = 176 for three separate studies), and (3) later replications found mixed evidence.

For instance, Open Science Collaboration (2015) reported a partial replication of the original Studies 2 and 3, which failed to find support for the original results. The replication found insufficient evidence that participants assigned to a social disconnection condition (vs. control or fear condition) had stronger belief in supernatural beings and anthropomorphized their pets more (see <https://osf.io/m5a2c> for the replication report). Nevertheless, these results should be interpreted cautiously, because the study might not have successfully manipulated participants’ emotional experiences: participants assigned to the social disconnection condition did not report feeling lonelier than those in the other conditions; also, those assigned to the fear condition did not report feeling more fearful). The replication also had a small sample size (81 participants were recruited for three between-subjects conditions). Given that a two-tailed independent-samples *t*-test with 27 data points per sample would have .80 power to only detect effects larger than *d* = 0.78, a non-typically large effect in social psychology (Lovakov & Agadullina, 2021; Richard et al., 2003), this replication was probably underpowered.

In a conceptual replication with a larger sample (*N* under analysis = 178), Bartz et al. (2016) randomly assigned participants to recall relationships either with a close other or an acquaintance, and found that chronic loneliness positively predicted anthropomorphism of technological gadgets regardless of experimental condition, *r*partial = .17. Also, those who recalled a close relationship (vs. relationship with an acquaintance) anthropomorphized the gadgets less after chronic loneliness was controlled for, *r*partial = −.15. There was, however, no support for effects on anthropomorphism of participants’ pets. In addition, the reported effect sizes in this conceptual replication were much smaller than those in the original studies. It is worth noting that, like the Open Science Collaboration (2015) replication, Bartz et al. (2016) might not have had sufficient power for detecting weak effects. With 178 participants, one has about .63 power to detect a *r*partial = .17 in a two-tailed test for a coefficient in a multiple regression model with four predictors, as in Bartz et al.’s study. Had the study been sufficiently powered, they would likely have obtained much smaller *p*-values than those reported, which were just below the .05 significance threshold (Simonsohn et al., 2014).

Given the impact of the original findings, the presence of some mixed evidence, and the limitations of previous (conceptual and direct) replications, we attempted a close high-power replication of the three studies reported in Epley, Akalis, et al. (2008). Specifically, we used the original Study 1’s design as a base and included anthropomorphism measures from Studies 2 and 3. This set-up is useful in addressing concerns about sample differences: with one large sample completing different anthropomorphism measures all at once, different replication results of these measures cannot be explained by any difference in sample characteristics. It is also powerful for drawing inferences about differences between the measures. For instance, while the loneliness-anthropomorphism association can remain consistent across measures, individual participants may not have responded to these measures consistently; if this happens to be the case, future research should investigate the source of such inconsistency, and what makes a measure appropriate for assessing anthropomorphism. The author team has published replication projects with similar set-ups, which provided critical insights on differences between measures and studies (e.g., Adelina & Feldman, 2021; Xiao et al., 2021; Yeung & Feldman, 2022).

## Extensions

Extensions are minor additions to replication studies that can potentially provide further insights into the phenomena under investigation. We therefore introduced several extensions to our replication.

### Anthropomorphism of supernatural beings

First, we assessed anthropomorphism of common supernatural beings in addition to the belief measure from the original Study 2 and 3. If lonelier people have, in general, a stronger tendency to anthropomorphize, it follows that they may also attribute more human characteristics to supernatural beings. Epley, Akalis, et al. (2008) found that feelings of social disconnection led participants to indicate a stronger belief in supernatural agents. Stronger beliefs in these agents, however, may not equate to perception of more human attributes. Hence, we included a measure on anthropomorphism of supernatural beings to test the association between loneliness and anthropomorphism more directly. This extension also provided us with one more category of targets to examine how robust the association is across different target categories.

### Belief in free will

Second, we explored potential associations between anthropomorphism and free will lay beliefs. Belief in free will is the generalized belief that humans are free from internal and external constraints across situations and captures a core aspect of human agency (Feldman, 2017; Lam, 2021; Nanakdewa et al., 2021). There are two competing hypotheses about the relationship between free will belief and anthropomorphism. On the one hand, a stronger belief in free-will implies an overall stronger tendency to attribute free will to others. This might extend to non-humans, especially when they are already perceived to have some degree of agency, thus predicting stronger anthropomorphism. On the other hand, many consider free will to be uniquely about human beings (Feldman, 2017), thinking that humans possess agency (i.e., the capacity to act independently of constraints, make free choices, and take responsibility) but non-humans do not. A stronger belief in free will may thus be associated with a subjectively sharper distinction between humans and non-humans and predict weaker anthropomorphism. Some theorized that our concept of free will evolved out of humans’ complex social networks: we believe we have free will because only as such can we inhibit our instinctual impulses for satisfying our immediate needs, follow cooperative rules that serve the long-term interest of the majority, and integrate ourselves into our cultural surroundings (Baumeister et al., 2011). There is some evidence that belief in free will is positively associated with prosocial behaviors, dispositional gratitude, and importantly, sense of belongingness (Baumeister et al., 2009; MacKenzie et al., 2014; Moynihan et al., 2017), and as such, negatively associated with anthropomorphic tendency.

To test these competing hypotheses, we measured free will belief as an extension. To the best of our knowledge, no study has explicitly tested the link between free will belief and anthropomorphism, making this extension worthy of adding.

### Controllability

As the final extension, we measured perceived controllability of the technological gadgets used in the original Study 1. The three-factor theory suggests that the motivation to predict and control one’s surroundings (i.e., effectance motivation) enhances anthropomorphism (Epley et al., 2007). Corroborating this idea, Waytz et al. (2010) found that people anthropomorphized gadgets perceived to be relatively unpredictable more than their predictable counterparts. Although we aimed primarily to replicate the association between sociality motivation and anthropomorphism, that Epley, Akalis, et al. (2008) and Waytz et al. (2010) used the same gadgets and the convenience of including just one more item measuring perceived controllability made it cost-effective to also try conceptually replicating Waytz et al.’s (2010) finding. We expected that the more participants found the gadgets uncontrollable, the more they would anthropomorphize those gadgets.

# Methods

IMPORTANT: Method and results sections were written using a randomized dataset produced by Qualtrics to simulate what these sections will look like after data collection. These will be updated following the data collection. This is written in past tense, yet no pre-registration or data collection have been conducted.

We determined our sample size by referring to previous findings. Epley, Akalis, et al. (2008, Study 1) observed a correlation of *r*(18) = .53 between loneliness and anthropomorphism of technological gadgets. This effect size, however, was probably an overestimate, being much larger than common effect sizes in social psychology (Lovakov & Agadullina, 2021; Richard et al., 2003) and those obtained in later replications (e.g., Bartz et al., 2016). Bartz et al. (2016) found loneliness to predict anthropomorphism with a small-to-medium effect size (*r*partial = .17) when non-anthropomorphic ratings of targets (e.g., strength, efficiency, attractiveness), participants’ gender, and experimental condition (recalling a close other vs. an acquaintance) were controlled for. Our power analysis with G\*Power (Faul et al., 2007) suggested that we would need 439 participants to detect this effect size with a linear multiple regression model that has two predictors (i.e., loneliness and non-anthropomorphic ratings), assuming a desired power of .95 and an alpha of .05 (see supplemental materials for details about the analysis). Since effect sizes in the literature are mostly overestimates (Button et al., 2013), we decided to err on the side of caution and collect a much larger sample of 1,000 participants, the maximum allowed by our budget, which ensures that we have good power to detect potentially small effect sizes and provide a more accurate effect size estimate. Meanwhile, a large sample size can also help compensate for failed attention checks and make well-powered moderator analyses possible (e.g., examining whether the order of measures has an effect).

## Participants

[] U.S. participants from Amazon Mechanical Turk completed our Qualtrics study via CloudResearch (Buhrmester et al., 2011; Paolacci & Chandler, 2014). After exclusion (see supplemental materials for criteria), we were left with [] participants (*M*age = [], *SD* = []; [] males [%], [] females [%], [] non-binary [%], and [] preferred not to disclose their gender [%]). We compensated each participant $[], which was pre-determined based on the U.S. minimum federal wage of $7.25 per hour. The average completion time was []; median was [].

## Design

The study was correlational. There were two predictor variables: (1) loneliness and (2) belief in free will, and four outcome variables: (1) anthropomorphism of gadgets (from the original Study 1), (2) belief in supernatural beings (from the original Study 2), (3) anthropomorphism of supernatural beings (an extension), and (4) anthropomorphism of pets (from the original Study 3). Unless otherwise specified, we randomized the order of items in the measurements that we used; we labeled only the endpoints with text anchors as well as numbers, whereas the middle options only had numeric labels.

### Predictor variables

#### Replication: Loneliness

To assess loneliness, we replaced the three-item short loneliness scale (Hughes et al., 2004) used in Epley, Akalis, et al.’s (2008) Study 1 with the longer, more frequently used, and more comprehensive UCLA Loneliness Scale (Russell, 1996), which nonetheless includes the three items of the shorter scale. Therefore, though we deviated from the original study in terms of measurement device, the replication part was not affected, since it is possible to conduct analyses using only those three items to mirror the original’s analyses. The UCLA Loneliness Scale has 20 items including, for example, “How often do you feel left out,” and “How often do you feel shy.” Participants responded to these items on a 4-point scale (1 = *Never*, 2 = *Rarely*, 3 = *Sometimes*, 4 = *Always*), and we averaged the responses to obtain an overall loneliness score (Cronbach’s α = [], McDonald’s ω*h* = []). Higher scores reflect greater loneliness.

#### Extension: Belief in free will

We measured belief in free will with the Free Will Subscale from the Free Will Inventory (FWI; Nadelhoffer et al., 2014). Participants indicated their agreement with five items (e.g., “People always have the ability to do otherwise”) on 7-point scales (1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Somewhat disagree*, 4 = *Neither agree nor disagree*, 5 = *Somewhat agree*, 6 = *Agree*, 7 = *Strongly agree*). The responses were averaged for an overall index of free will belief (α = [], ω*h* = []).

#### Attention checks

Two attention check items were inserted in the UCLA Loneliness Scale and the Free Will Subscale, respectively, each asking participants to select a certain response option on the scale. We excluded participants who fail any of these checks. Adding attention checks was a deviation since none were included in the original study. However, they are low-cost and efficient in helping protect scale validity, identify unserious respondents, and as such, improve data quality (Berinsky et al., 2014; Kung et al., 2018; Shamon & Berning, 2020). As such, we decided to deviate and include them.

### Outcome variables

#### Technological gadgets

Participants read about four technological gadgets (e.g., “Clocky is a wheeled alarm clock that looks like a furry animal and operates in a way that makes it difficult to repeatedly press snooze in the morning. When you press snooze, Clocky either runs away from you or jumps on top of you so that you must get up to turn it off.”) and rated each on five anthropomorphic measures (i.e., the extent to which the gadget has “a mind of its own,” “intentions,” “free will,” and “consciousness,” as well as “experience emotions”; α = [], ω*h* = []), three non-anthropomorphic measures (i.e., “strong,” “efficient,” and “attractive”; α = [], ω*h* = []), and one extension measure on perceived controllability (i.e., “can be controlled”) on 7-point scales (0 = *Not at all*, 6 = *Very much*). We calculated anthropomorphic and non-anthropomorphic composite measures by taking the average of the item scores first within each gadget and then across all four gadgets.

#### Supernatural beings

Participants indicated the extent to which they believed in six supernatural beings (ghosts, angels, miracles, curses, the Devil, and God) on 7-point scales (0 = *Not at all*, 6 = *Very much*).[[1]](#footnote-2) We calculated a composite measure for belief in supernatural beings by averaging responses to these six items (α = [], ω*h* = []). Participants also rated the extent to which a ghost, an angel, the Devil, and God “experiences emotions,” “has consciousness,” “has intentions,” “has a mind of its own,” and “has free will” (7-point scale; 0 = *Not at all*, 6 = *Very much*). We took the grand average of these ratings to form a measure of anthropomorphism of supernatural beings.

Participants also reported whether they believed in God (binary; yes or no) and were then split into believers and non-believers. Believers reported their level of religiosity on a 5-point scale (1 = *Very slightly*, 5 = *Extremely*) (non-believers did not see this question).

#### Pets

Participants were asked to think of a pet that they either owned or were familiar with and provide some basic information about the pet. Then, participants picked three traits that they thought best described the pet from a list of 14, including three anthropomorphic traits that are related to social connection (thoughtful, considerate, and sympathetic), four anthropomorphic traits that are less related to social connection (embarrassable, creative, devious, and jealous), and seven non-anthropomorphic traits (aggressive, agile, active, energetic, fearful, lethargic, and muscular). We recorded the proportions of traits selected from each category as outcome measures.[[2]](#footnote-3)

## Procedure

FOR REVIEW: The Qualtrics survey, .qsf file and an exported .docx file are provided in the OSF folder.

Participants provided their consent in the beginning, read an outline of this study, and answered screener questions that asked about their ability and willingness to participate in the study. If they did not answer these questions affirmatively, their session would be terminated. This helped us screen out those who tended to randomly click through surveys. Participants then completed the predictor and outcome measures. The measures were separated into five blocks as per the sections above, and the blocks were presented in random orders. In the end, participants completed a funneling section and provided their demographic information.

Our randomizing the order of measures was a deviation because the original study presented them in a fixed order, where the loneliness measure appeared after the gadget anthropomorphism task. We consider the random presentation order a strength of our study that enables us to address any concerns about order. With our large sample size, we could test possible order effects, and this might bring additional insights about study designs. [Note: In case we fail to find support for the original’s hypotheses, we will test for order effects (order as a moderator).]

## Deviations

We summarized our deviations from the original study in the supplemental materials (Table S4). We classified our replication as a *very close replication* based on LeBel et al.’s (2018) criteria (summarized in Table S3).

## Hypotheses

In line with the original study, we hypothesized that loneliness is positively associated with anthropomorphism. As extensions, we also predicted that free will is associated with anthropomorphism (though we did not make predictions on its direction) and that perceived controllability of targets is negatively associated with anthropomorphism. We note the hypotheses more specifically below:

### Replication hypotheses

H1a: Loneliness is positively correlated with anthropomorphic ratings of gadgets.

H1b: Loneliness is positively correlated with non-anthropomorphic ratings of gadgets.

H1c: Loneliness is positively correlated with anthropomorphic ratings of gadgets after non-anthropomorphic ratings are controlled for.

H1d: Loneliness is positively correlated with anthropomorphism of pets (measured as the proportion of social connection-related traits that were selected).

H1e: Loneliness is positively correlated with belief in supernatural beings.

H1f: Loneliness is positively associated with anthropomorphism of supernatural beings.

### Extension hypotheses

We tested the following extension hypotheses: First, for each of the hypotheses above (i.e., H1a to H1f), we replaced “loneliness” with “belief in free will” and derived our H2a to H2f (testing “positively”) and H3a to H3f (testing “negatively;” that is, we had two sets of hypotheses to be clear that we had no prediction over the direction of the associations involving free will belief). Finally, concerning perceived controllability:

H4: Perceived controllability of gadgets negatively predicts anthropomorphic ratings after non-anthropomorphic ratings are controlled for.

## Open practices statement

We registered the study protocol on the Open Science Framework (OSF) on [date] following its in-principle acceptance, and data collection was launched on [date]. Pre-registrations, power analyses, and all materials used in these experiments are available in the supplemental materials. We provided all materials, data, code, and pre-registration at <https://osf.io/2sb7x/>. We also provided additional open-science details and disclosures in the supplemental materials under “Open Science disclosures” section. We confirm that all measures, manipulations, exclusions conducted for this investigation have been reported, all studies were pre-registered with power analyses, and data collection was completed before any formal analysis.

# Results

IMPORTANT: Method and results sections were written using a randomized dataset produced by Qualtrics to simulate what these sections will look like after data collection. These will be updated following the data collection. This is written in past tense, yet no pre-registration or data collection have been conducted.

We report the results after exclusion in the main text and the full sample results in the supplemental materials.

## Confirmatory analyses

We presented the descriptive statistics and the zero-order Pearson correlation matrix for key variables in Table 1.

### Loneliness and anthropomorphism

#### Gadgets

We found a weak positive association between loneliness and anthropomorphic ratings of gadgets, *r*(198) = .02, 95% CI [−.12, .16], *p*one-sided = .394 (with only the three items of the shorter loneliness scale used in the original study: *r*() = [we omitted these because these are similar with some of the demonstrated analyses], 95% CI [], *p*one-sided = []), and a small negative association between loneliness and non-anthropomorphic ratings of gadgets, *r*(198) = −.14, 95% CI [−.28, −.00], *p*one-sided = .978 (with only the three items of the shorter scale: *r*() = [], 95% CI [], *p*one-sided = []). Also, we found no evidence that loneliness was positively associated with anthropomorphic ratings of gadgets after non-anthropomorphic ratings were controlled for, *r*partial = .01, 95% CI [−.13, .15], *p* = .887 (with only the three items of the shorter scale: *r*partial = [], 95% CI [], *p* = []). Overall, we found little evidence that loneliness was positively associated with anthropomorphism of technological gadgets.

Table 1.

*Descriptives and Pearson correlation matrix for key variables*

[Note: Statistics are based on simulated random data!]

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | ***M*** | ***SD*** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| 1. Loneliness (UCLA) | 2.52 | 0.26 | [] |  |  |  |  |  |  |  |
| 2. Loneliness (3-item short scale) | 2.51 | 0.63 | \*\*\*.51 | [] |  |  |  |  |  |  |
| 3. Belief in free will | 3.93 | 0.92 | .09 | −.03 | [] |  |  |  |  |  |
| 4. Gadget anthropomorphism | 2.96 | 0.42 | .02 | .09 | −.04 | [] |  |  |  |  |
| 5. Gadget non-anthropomorphism | 3.01 | 0.57 | \*−.14 | \*−.15 | .09 | −.06 | [] |  |  |  |
| 6. Pet anthropomorphism | 0.21 | 0.22 | −.02 | −.11 | .01 | −.11 | .09 | - |  |  |
| 7. Belief in supernatural beings | 3.02 | 0.81 | .03 | .01 | −.02 | −.01 | .01 | −.01 | [] |  |
| 8. Anthropomorphism of supernatural beings | 2.97 | 0.46 | .08 | .04 | −.08 | −.03 | −.03 | .06 | −.04 | [] |
| *Notes*. Gadget anthropomorphism = anthropomorphic ratings of gadgets; gadgets non-anthropomorphism = non-anthropomorphic ratings of gadgets; pet anthropomorphism = proportion of social connection-related traits selected for describing participants’ pets well.  \**p* < .05, \*\**p* < .01, \*\*\**p* < .001  Omega (hierarchical) coefficient (where applicable) are shown in the diagonal. | | | | | | | | | | |

#### Pets

We found no evidence that loneliness was positively correlated with the proportion of social connection-related anthropomorphic traits (out of this particular category) selected by participants for describing their pets well, *r*(198) = −.02, 95% CI [−.16, .12], *p*one-sided = .617. As such, there is no evidence that loneliness was positively associated with anthropomorphism of pets.

#### Supernatural beings

We found no evidence that loneliness was positively correlated with belief in supernatural beings, *r*(198) = .03, 95% CI [−.11, .17], *p*one-sided = .322. Also, there was little evidence that loneliness was positively associated with anthropomorphism of supernatural beings, *r*(198) = .08, 95% CI [−.06, .21], *p*one-sided = .135.

### Free will belief and anthropomorphism

[The same analyses as above will be performed, with loneliness replaced by belief in free will. However, since we have competing hypotheses about the direction of relationships, we will always perform two-sided tests.]

### Perceived controllability and anthropomorphism

The three-factor theory of anthropomorphism suggests that the motivation to understand and control our surroundings leads to anthropomorphism (Epley et al., 2007). With the extension measure of “perceived controllability” in the gadget anthropomorphism task, we tested whether perceived controllability of gadgets was negatively associated with their anthropomorphism. For this purpose, and considering that the data are fully crossed, we built a series of linear mixed-effects models with the *lme4* (Bates et al., 2015) and the *lmerTest* (Kuznetsova et al., 2017) R packages. Our full model included anthropomorphic mental-state ratings of gadgets as the outcome variable and perceived controllability and non-anthropomorphic ratings as predictors. We included both random intercepts and slopes for the predictors on participant and gadget levels (Baayen et al., 2008). Degrees of freedom were approximated with the Satterthwaite’s method.

[Given that we only have four gadgets, including random slopes for gadgets will likely lead to non-convergence. In such a case, we will take the following steps to simplify the model: (1) remove random slopes for gadgets (for both predictors; same in the following); (2) remove random slopes for participants; (3) remove random intercepts for gadgets; and (4) finally, remove random intercepts for participants, which results in a fixed-effects model. The simplification ends first at convergence, and then we will conduct likelihood-ratio tests to determine whether this model has the best fit for the data and is also simple. If a simpler model fits the data as well (i.e., no significant difference in fitness), we will opt for the simpler model. If the tests suggest that the fixed-effect model after Step (4) fits the data as well as the simplest mixed-effects model, we will report the results based on the fixed-effect model, because it is the simplest.]

## Exploratory analyses

We conducted the following analyses that yielded some interesting results. They, however, must be considered preliminary due to the exploratory nature of these analyses.

[One reviewer suggested we should examine whether, and to what extent, free will belief is related to anthropomorphism when items tapping on free will are removed from those anthropomorphism measures. We conducted these exploratory analyses. (Report results)]

[More to be added at Stage 2]

## Evaluating replication results

[To be added at Stage 2]

# Discussion

[To be added at Stage 2]

## Limitations (Planned discussion)

[Based on feedback provided in the peer review process we aim to discuss the free will extension and the possibility of a correlation between free-will beliefs regarding human agents and free-will attributions towards non-humans.]

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1. The original article used a 10-point scale (1 = *Not at all*, 10 = *Very much*). To avoid confusion and to minimize the mental effort in switching between scales with different numbers of scale points, we decided to deviate from the original and use the same 7-point scale as in the gadget task. Research has shown that this change is unlikely to result in a psychometric disadvantage for the measure (e.g., Simms et al., 2019). [↑](#footnote-ref-2)
2. A similar measure in the literature (e.g., Epley, Waytz, et al., 2008) asked participants to rank the traits in terms of how well each describes their pets. The average rank of each category of traits was then correlated with participants’ loneliness. Epley, Waytz, et al. (2008) found a significant negative association between loneliness and the average rank assigned to social connection-related traits (*r*(164) = −.18, *p* = .02). The associations between loneliness and the average ranks of the other two types of traits were not statistically significant. [↑](#footnote-ref-3)