The association between anthropomorphism of nature and pro-environmental variables: a systematic review

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Abstract

It is taken for granted that anthropomorphising non-human species promotes pro-environmental attitudes and behaviours, but the literature appears to be conflicted on this topic. There is also little discussion in the literature as to whether there are different types of anthropomorphism that may be particularly associated with pro-environmental attitudes and behaviours. This is the first systematic review to address the hypothesis that there is a significant association between anthropomorphism of nature and pro-environmental variables, and that anthropomorphism has a beneficial causal role. This review synthesises results from 25 studies (18 correlational; seven experimental) in addressing this hypothesis, weighing its conclusions by an appraisal of study quality. This review presents evidence from high quality studies that mind attribution to non-human entities is consistently associated with pro-environmental variables, and that inducing anthropomorphic perceptions of non-human entities can generate pro-environmental outcomes in some circumstances. The authors also summarise the highest-quality evidence with regard to the possible mediators of the relationship between anthropomorphism and pro-environmental variables, and consider the findings through the lens of the theory of planned behaviour (Ajzen, 1991). The implications of the findings for future research and conservation campaigns are discussed alongside a note of caution about the limitations and potential disadvantages of anthropomorphism.

Keywords

Anthropomorphism; mind attribution; pro-environmental behaviour; attitudes; conservation; systematic review

1. Introduction

Campaigns commonly present nature in a way that highlights, or fabricates, its similarity to humans, with the aim of influencing pro-environmental attitudes and behaviours. An emotive advert for the supermarket chain Iceland in the UK portrayed a talking cartoon Orangutan to warn against the environmental impact of palm oil cultivation, and was banned for being too political (Butler & Sweney, 2018). In 2006, Al Gore noted on “Good Morning America” that “The Earth has a fever and just like when your child has a fever, maybe that’s a warning of something seriously wrong,” (“Al Gore: There’s Still Time To Save the Planet”, 2006). Such messages are conveyed without firm empirical grounding for their effectiveness, as research on portraying nature as similar to humans, and whether it can lead to pro-environmental behaviours, is still in its infancy.

One approach that researchers have taken to investigate this association is to look at correlations between human-like characteristics of species and their association with conservation attitudes and behaviours toward those species. Batt (2009), for instance, generated an overall measure of objective similarity of species to humans across a range of “biobehavioural” variables (p. 181), which incorporated, e.g., reproductive strategy and size. Batt reported more positive attitudes among a university sample toward species that had been deemed objectively similar to humans on these variables. Understanding the association between pro-environmental variables and species’ objective similarity to humans may provide empirical basis for the use of flagship species with human-like physical characteristics, such as forward-facing eyes (Smith, Veríssimo, Isaac, & Jones, 2012).

Anthropomorphism, by contrast, is a more subjective assessment of species similarity to humans. Epley, Waytz, and Cacioppo (2007) define anthropomorphism as “Imbuing the imagined or real behaviour of nonhuman agents with human-like characteristics, motivations, intentions, and emotions,” (p. 864). Understanding humans’ subjective assessments of similarity has received very little focus in environmental research, despite being an important frontier in environmental research for a multitude of reasons. For one, many species characteristics are imperceptible to the non-expert and must be inferred, such as consciousness, capacity to feel pain, or to feel emotions (although these capacities have been revealed by scientific studies; Bekoff, Allen, & Burghardt, 2002). The importance of such

inferences for pro-environmentalism is self-evident when one considers linguistic conventions that personify nature (e.g., “Mother Earth”), and movements such as veganism, which often highlight the sentience of animals (e.g., Hooley & Nobis, 2015). Second, influencing anthropomorphic perceptions of non-human species is an under-explored avenue for encouraging pro-environmental attitudes and behaviours among the public.

Researchers have found anthropomorphism of nature to be positively correlated with pro-environmental attitudes (e.g., Apostol, Rebega, & Miclea, 2013) and there is some experimental evidence that manipulating anthropomorphism leads to increases in pro-environmental attitudes (e.g., Wang, Ming, & Zhang, 2020). Some of the evidence has been conflicting, however; Tam (2015a), for example, presents experimental evidence that the influence of anthropomorphism on pro-environmental outcomes can be contingent on participants’ pre-existing need for social connection, and can be counterproductive for those with low need.

There are theoretical reasons why anthropomorphism may, in different contexts, help or hinder the pro-environmental cause. While Chan (2012) theorises that anthropomorphism of species should lead to greater desire to save their lives via an increase in empathy, this author also cautions against the indiscriminate use of anthropomorphism, which could, for instance, lead to inadvertent support for the killing of a predator to that species. Indeed, Root-Bernstein, Douglas, Smith, and Verissimo (2013) provide empirical evidence that anthropomorphism can have adverse consequences for environmental attitudes, citing a study by Knight (2005) in which Japanese zoo visitors who perceive monkeys’ feeding interactions to be akin to human gift-giving behaviour come to be disappointed in behaviour that violates perceived norms, such as stealing and fighting between the monkeys.

It may be that different sorts of perceived similarity are particularly important when considering pro-environmental variables. Although researchers have not explicitly specified subtypes of anthropomorphism, mind attribution is one type of perceived similarity that has been given special focus (e.g., Higgs, Bipin, & Cassaday, 2020). This entails ascribing mental capacities to non-human entities, such as emotions, thoughts, and consciousness, and might be considered in contrast to perceiving more superficial similarities between humans and nature/species, such as observable behaviours.

Settling the question of anthropomorphism and the contexts in which it might be a useful tool for pro-environmental campaigns is further impeded by study quality. Correlational studies that measure the associations between anthropomorphism and other variables often do not control for the influence of related variables that might explain the association, such as age and gender, and there are few experiments that manipulate anthropomorphism to assess its impact, although these are growing in number. At this juncture it would be sensible to summarise the findings from highest quality studies on this topic, which may allow for a more scientifically-informed use of anthropomorphism in pro-environmental campaigns.

The theory of planned behaviour (TPB; Ajzen, 1991) is a helpful theoretical framework for selecting pro-environmental variables of interest, as it has been shown to be valid in explaining the occurrence of conservation and other pro-environmental behaviours (De Leeuw, Valois, Ajzen, & Schmidt, 2015). Therefore, in addition to pro-environmental behaviours, the researchers were interested in how anthropomorphism might be associated with the psychological variables that the TPB holds to be predictive of behaviour: beliefs (behavioural, normative, control), attitude (toward the behaviour, species, and the environment), subjective norms, perceived and actual behavioural control, and intention to perform the behaviour.

This narrative systematic review aims to summarise the research that has associated perceived similarity with pro-environmental beliefs, attitudes, norms, behavioural control, intentions, and behaviours, and addresses two principal questions: 1. is there a significant positive association between anthropomorphism and these variables, and 2. is there reliable causal evidence from experiments that anthropomorphism can lead to pro-environmental behaviours and TPB constructs? Results from studies

will be synthesised to address three subsidiary questions: 1. Have researchers specified subtypes of anthropomorphism when investigating associations with pro-environmental outcomes?; What might mediate the association between anthropomorphism and these variables?; 3. What factors might moderate the benefits of anthropomorphism for pro-environmental outcomes? Conclusions drawn from included studies will be weighted by study quality.

2. Method

2.1 Searches

Searches were conducted on 28.10.2020 through Web of Science, PubMed, Scopus, PsycINFO, and ERIC (see Table 1 for the search terms).

Scoping searches provided a survey of the field and different kinds of anthropomorphism that were studied, which led to the inclusion of "mind attribution" and "animal mind" as terms to reflect particular forms of anthropomorphism.

Table 1

Search terms

Anthropomorphism search terms		Nature and species-related search terms		Variables of interest search terms
anthropomorph* OR "mind attribution" OR "animal mind"	AND	species OR wildlife OR animal* OR nature	AND	belief* OR attitud* OR norm* OR control OR intention* OR efficacy OR behav*

2.2 Inclusion criteria

Studies were included if:-

- They reported quantitative analysis (correlation or regression) of the association between a measure of anthropomorphism/mind attribution of non-human species and an outcome relating to pro-environmental behaviours (belief, attitude, norm, intention, efficacy, behaviour) or attitudes toward species/nature

OR

- They reported quantitative analysis of the effect of experimental manipulation of anthropomorphism/mind attribution of non-human species on one of these outcomes

AND

- They were written in English.

Peer-reviewed published and grey literature were included.

2.3 Quality Appraisal

2.3.1 Quality Appraisal Method. Quality appraisal was conducted for each paper to determine internal validity (i.e., the results were a true representation of the relationship between variables under study) and sources of bias that might misrepresent the population under study. For correlational designs, quality could only be assessed with regard to their ability to answer a non-causal hypothesis, i.e., that there is a statistical evidence of an association between the variables. For experimental designs, quality could be assessed in relation to whether the study results could be relied upon to draw causal conclusions.

Due to quality appraisal tools having originated in the healthcare field for testing the effectiveness of health-related interventions, there are few quality assessment tools designed specifically for environmental psychology, and in particular correlational designs. A tool from the National Heart, Lung, and Blood Institute (NHLBI; https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools) for assessing cross-sectional designs was adapted for the purposes of quality appraising papers with correlational designs in the present review, as this is the only tool with guidelines that deals with such designs to the authors' knowledge. Table 2 shows the items included to assess the correlational papers and the reasons for their inclusion (see Table S2 for excluded items).

Table 2

Quality criteria for appraisal of correlational papers

Items for correlational papers	Reasons for inclusion
1. Was the research question or objective in this paper clearly stated?	This implies an a priori hypothesis and increases the likelihood that presented analyses were hypothesis-driven
2. Was the study population clearly specified and defined?	This allows for generalisability to be assessed
5. Was there a sample size justification based on a power analysis, or was an effect size reported for the analyses of interest?	This allows the authors to determine how meaningful the results are, beyond statistical significance
9. Were the measures of interest clearly defined, valid, reliable, and implemented consistently across all study participants?[1]	Unestablished psychometric properties and inconsistent use of measures would detract from the study's internal validity
Additional item: Did relevant correlations control for any other variable(s)?	This item was added as it was deemed an important aspect of testing the validity of a correlation

1 Item 9 was derived by collapsing two items and modifying their wording:- 9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?; 11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?

Experimental studies were quality-checked against the first four items as the correlational studies, and the fifth item (relating to whether correlations controlled for any other variable(s)) was not deemed as relevant to experimental studies which can control for extraneous variables through randomisation and testing for equivalence of baseline group characteristics. Four additional quality appraisal items were applied to experimental studies, which were derived from the NHLBI's tool for the "Quality Assessment of Controlled Intervention Studies" (see Table S3 for excluded items.) A fifth item was added by the researchers for assessing experimental study quality, which related to manipulation checks. Table 3 shows the four additional items for rating study quality, and the reasons for their inclusion.

Table 3

Quality criteria for appraisal of experimental papers

Items for experimental papers	Reasons for inclusion
1. Were participants randomised to groups? (original wording: "Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT?")	Randomisation limits the risk of group differences post-manipulation being attributable to important differences in non-manipulated variables that existed at baseline
2. Was the method of randomisation adequate (i.e., use of randomly generated assignment)?	It is important to use a truly random method for the process of randomisation

6. Were the groups similar at baseline on important characteristics that could affect outcomes (e.g., demographics, risk factors, co-morbid conditions)?	Similarity of baseline characteristics allows for more confidence that any observed effect can be attributed to the experimental manipulation
Additional item: Did a manipulation check show that the manipulation had the intended effect?	This item was added by the researchers as an important aspect of social psychology experiments that allow a causal hypothesis to be answered more reliably

Two independent raters (the study authors) assessed each of the included 18 studies against the above criteria, with four possible response options to indicate whether the criterion was fulfilled: Yes, could not determine, or no. For calculation of inter-rater reliability of scores, responses were transformed into three categories (Yes = 1; Partial = 0.5; No/could not determine = 0). A response option of 'Partial' was added for item 4 only (good quality measures and consistent implementation) as it was found that studies frequently included a mixture of validated and non-validated measures, and including a 'partial' response allowed for more nuance in the reporting of study quality on this criterion.

A Kappa value of .78 was calculated based on the categories of the two raters' quality appraisals, which is in the "substantial" agreement range (i.e., between 0.61 - 0.80; Landis & Koch [1977]). Reviewers reached agreement through negotiation with regard to items where their ratings conflicted, and generated an overall rating of study quality by summating the scores on each criterion for each study based on the following criteria:-

For correlational studies, the score boundaries of categories was: Poor = below 3; Fair = between 3 and 4.49; Good = 4.5 and above.

For experimental studies, the score boundaries of categories was: Poor = below 5; Fair = between 5 and 5.99; Good = 6 and above

Quality category score boundaries for correlational and experimental studies were chosen first by deciding on the quality cut-off where studies' results were deemed unreliable, and then the score boundaries for the 'Fair' and 'Good' categories were chosen to provide maximal diversity in quality categories whilst maintaining sufficient quality standards.

2.3.2 Quality Appraisal Results. See Tables 4 and 5 for results of quality appraisal for correlational and experimental studies, respectively. It should be noted that this is not an overall judgement of the study, but an estimation of the strength of the study's results as evidence relating to the present review's question.

Table 4

Quality Appraisal for Correlational Studies

Authors	1. Question clearly stated	2. Population clearly specified	3. Power analysis/ effect size	4. Good quality measures and consistent implementation	5. Correlations controlled for other variable(s)	Overall quality rating
Apostol et al. (2013)	Yes	Yes	Yes	Partial	Yes	Good
Díaz (2016)	No	Yes	Yes	Yes	Yes	Fair

Hawkins et al. (2020)	Yes	Yes	Yes	Partial	No	Fair
Higgs et al. (2020)	No	No	Yes	Yes	Yes	Fair
Knight et al. (2004)	Yes	Yes	Yes	Partial	No	Fair
Maguire et al. (2020)	Yes	Yes	Yes	Partial	Yes	Good
Manfredo et al. (2020)	Yes	Yes	Yes	Yes	Yes	Good
Riepe & Arlinghaus (2014)	Yes	Yes	Yes	Partial	Yes	Good
Tam (2013, Study 5)	Yes	Yes	Yes	Yes	Yes	Good
Tam et al. (2013, Study 1)	Yes	Yes	Yes	Partial	No	Fair
Tam (2014, Study 1)	Yes	Yes	Yes	Partial	Yes	Good
(Study 2)	Yes	Yes	Yes	Partial	Yes	Good
Tam (2015b, Study 1)	Yes	Yes	Yes	Partial	Yes	Good
(Study 2)	Yes	Yes	Yes	Partial	Yes	Good
(Study 3)	Yes	Yes	Yes	Partial	Yes	Good
Tam (2019, Study 1)	Yes	Yes	Yes	Partial	Yes	Good
(Study 2)	Yes	Yes	Yes	Yes	Yes	Good
(Study 3)	Yes	Yes	Yes	Partial	Yes	Good

Table 5

Quality Appraisal for Experimental Studies

Authors	1. Question clearly stated	2. Population clearly specified	3. Power analysis/effect size	4. Good quality measures and consistent implementation	5. Randomisation	6. Adequate randomisation	7. Baseline equivalence of confounding variables	8. Checks confirming effectiveness of manipulation	Overall quality rating
Brown & McLean (2015, Study 2)	Yes	No	Yes	Partial	Yes	CND	No	No	Poor
Butterfield et al. (2012, Study 1)	Yes	No	Yes	Partial	Yes	CND	No	No	Poor
(Study 2)	Yes	No	Yes	Partial	Yes	CND	No	No	Poor
Laksmidewi & Soelasih (2019, Study 2)	Yes	No	No	Partial	Yes	CND	No	Yes	Poor
Tam et al. (2013, Study 3)	Yes	Yes	Yes	Yes	Yes	CND	No	Yes	Good
Tam (2014, Study 3)	Yes	Yes	No	Partial	Yes	CND	No	No	Poor
Tam (2015a, Study 1)	Yes	Yes	Yes	Partial	Yes	CND	No	No	Fair
(Study 2)	Yes	Yes	Yes	Partial	Yes	CND	No	No	Fair
Wang & Basso (2019, Study 2)	Yes	Yes	Yes	Partial	Yes	CND	No	Yes	Fair

(Study 3a)	Yes	Yes	Yes	Partial	Yes	CND	No	Yes	Fair
(Study 3b)	Yes	Yes	Yes	Partial	Yes	CND	No	Yes	Fair
(Study 3c)	Yes	Yes	Yes	Partial	Yes	CND	No	Yes	Fair
Wang et al. (2020, Study 1)	Yes	No	No	Partial	No	CND	No	No	Poor
(Study 2)	Yes	No	No	Partial	No	CND	No	No	Poor
(Study 3)	Yes	No	No	Partial	Yes	CND	No	Yes	Poor

Due to the above ratings, eight experimental studies (rated "Poor") were excluded from further consideration in this review: Brown & McLean (2015, Study 2), Butterfield et al. (2012, Studies 1 & 2), Laksmidewi & Soelasih (2019, Study 2), Tam (2014, Study 3), and Wang et al. (2020, Studies 1 - 3).

2.4 PRISMA Flowchart

Figure 1 shows the PRISMA flowchart of the total papers obtained from searches and their exclusion at each stage.

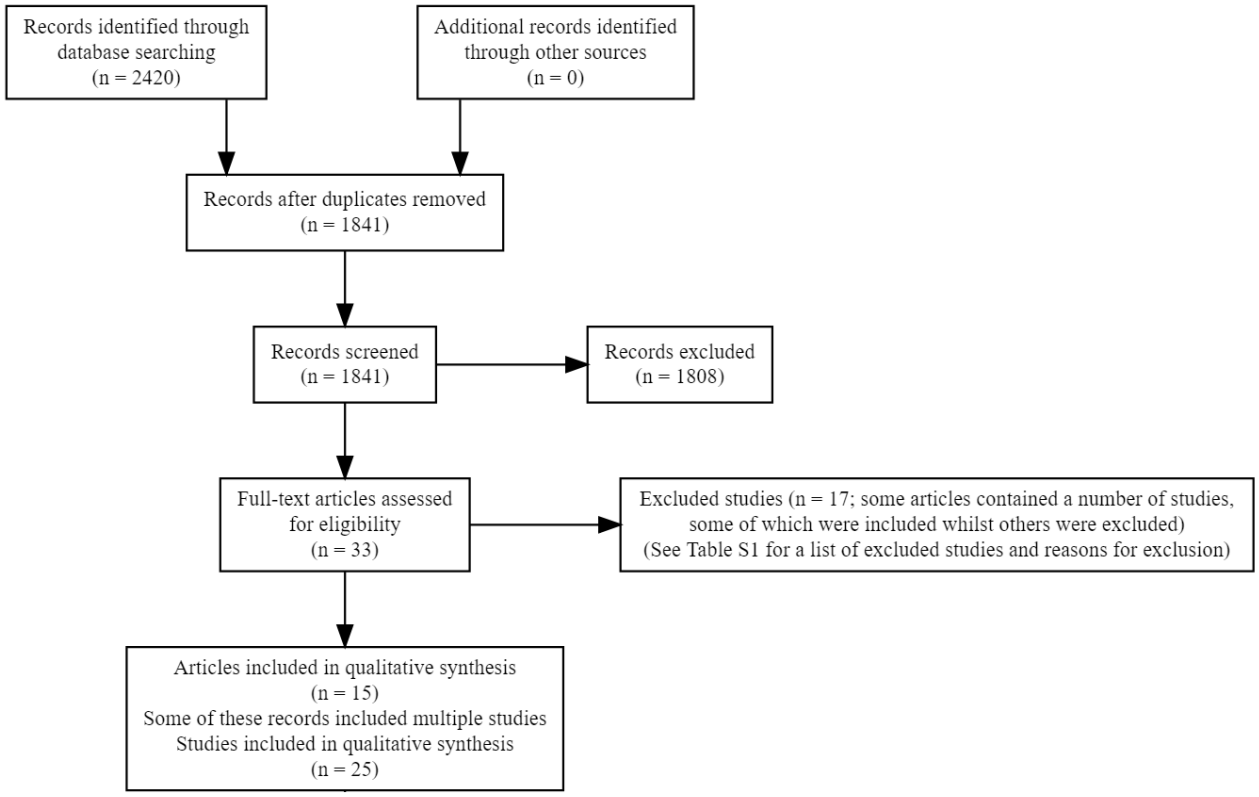

Figure 1. PRISMA flowchart

3. Results

See Tables 6 and 7 for a summary of the findings from the correlational and experimental studies, respectively, following quality appraisal. When statements are made about a finding, these all relate to significance in which $p < .05$. It should be noted that, although some studies were reported in the same paper, all studies reported results from different datasets.

217 Table 6

218 *Summary of findings from retained correlational studies.*

Authors	Country	Participant population	Sample Size (N)	Measure of Anthropo-morphism	Measures of Outcomes/ Controlled Variables	Findings & Effect Sizes
Apostol et al. (2013)	Romania	General population, (adults and children, mean age = 36.54, SD = 12.63, range = 14 - 77)	2,683	Belief in Animal Mind Questionnaire (Hills, 1995)	Empathy: Empathy to Animals Scale (Powell, 2010); Attitudes: Attitudes to Animals Scale (Herzog Jr, Betchart, & Pittman, 1991)	Significant positive correlations were found between belief in animal mind and more positive attitudes toward animals (r = .297); a hierarchical regression showed belief in animal mind to be significantly predictive of positive attitudes toward animals (adjusted R^2 = 0.09) even when gender, age pet ownership, education, residence, empathy to animals, empathic concern, and perspective taking were included in the analysis (although belief in animal mind was the third-strongest predictor after empathic concern and perspective taking)
Díaz (2016)	Spain	University students (mean age = 23.26; SD = 6.1)	481	Items from the Attributes Questionnaire (Herzog & Galvin, 1997) to measure five attitudes/beliefs toward species: affection for species and belief in animal consciousn	A shorter version of the Attitudes Toward the Use of Animals (adapted from Meng, 2009); questions about diet (e.g., meat-eater / vegan); questions about intention to 1. become vegetarian and 2. become vegan in the next two years	Of the five types of attitude, deservingness of moral consideration showed the strongest and highest number of correlations with beliefs in the use of animals (higher moral consideration associated with lower belief in use of animals), in which 20/21 uses of animals showed correlations with moral consideration; affection toward species and three beliefs about animal mentation (they are conscious, can feel emotions and can suffer) together predicted moral consideration of species (R^2 = 0.47). When all variables were included together, only affection toward species and moral concern predicted intention to become vegetarian and vegan, albeit with low variance explained by

				ess, ability to suffer, to feel emotions, and worthiness of moral consideration, applied to 13 different animal species		the model (vegetarian: R^2 = 0.09; vegan: R^2 = 0.15)
Hawkins et al. (2020)	Scotland	Primary school children (mean age = 9.7; SD = 1; range = 6.4 - 12.2)	1,217	Children's Beliefs about Animal Minds (Hawkins & Williams, 2016)	Children's Attitudes towards Animal Cruelty Questionnaire (both intentional and unintentional cruelty; adapted from Connor, Currie, & Lawrence, 2018)	Lower belief in animal mind was associated with higher acceptance of animal cruelty as a whole (r = 0.14) and higher acceptance of intentional cruelty specifically (r = 0.11)
Higgs et al. (2020)	United Kingdom	General population (snowball sampling; mean age = 38; SD = 15.98; range = 18 - 80)	317	Belief in Animal Mind Questionnaire (adapted from Hills, 1995)	Animal Purpose Questionnaire (developed as part of the study)	Belief in animal mind was found to be significantly predictive of lower agreement with the killing of animals even after controlling for gender, age, ethnicity, religion, eating orientation, education, working with animals, and being a scientist, contributing R^2 = 0.10 additional variance to the model
Knight et al. (2004)	United Kingdom	General population (mean age = 39.3; SD = 13.9)	96	Belief in Animal Mind Questionnaire (adapted	A questionnaire about six different types of animal use (no reference is provided for this measure)	Higher belief in animal mind was associated with lower support for animal experimentation and less support for animal use (for personal decoration, entertainment, financial gain, animal management issues, and using animals in the classroom (lowest r = 0.46, highest r = 0.53), even when

				from Hills, 1995)		controlling for other factors (age, gender, pet ownership, meat eating, political stance, and living area)
Maguire et al. (2020)	Australia and Kingdom of Tonga	General population (mean age = 33.93; SD = 13.98)	45	Adapted Individual Differences in Anthropomorphism Questionnaire (Waytz, Cacioppo, & Epley, 2010) to ask questions about anthropomorphism of whales	Empathy: Interpersonal Reactivity Index adapted for animals (Norring, Wikman, Hokkanen, Kujala, & Hänninen, 2014); conservation behaviours: Conservation Behavior Scale (Schultz, 2000); connectedness to nature: Connectedness to Nature Scale (Mayer & Frantz, 2004)	Anthropomorphism was not uniquely predictive of conservation behaviour when nature connection, perspective-taking and empathic concern were included in the regression model (only nature connection was a unique predictor)
Manfredo et al. (2020)	United States	General population (no summary of sample age provided)	43,939	Adapted Individual Differences in Anthropomorphism Questionnaire (Waytz et al., 2010) to ask questions about anthropomorphism of wildlife; added two	Values: 19-index survey about mutualism and wildlife values (Teel & Manfredo, 2010); Attitudes toward carnivores involved in human-wildlife conflict situations: bespoke items	A mediation analysis was consistent with a hypothesised model in which anthropomorphism reduces support for lethal management of carnivores largely via mutualism values

				items to ask participants about extent to which they believe wildlife have consciousness and have free will		
Riepe & Arlinghaus (2014)	Germany	General population (adults and children, age range = 14 - 92 [no mean age provided])	1,043	Attributes Questionnaire (Herzog & Galvin, 1997)	Values and Beliefs Relating to Recreational Fishing: Two Wildlife Values Orientation scales (Teel, Dayer, Manfredo, & Bright (2005); Manfredo, Teel, & Henry (2009), adapted to ask specifically about values and beliefs pertaining to recreational fishing; Support for Animal Rights: adaptation of the Animal Rights Scale (Wuensch, Jenkins, & Poteat, 2002)	Anthropomorphism did not predict variance in attitudes toward recreational fishing, and the hypothesis therefore that anthropomorphism would mediate the association between wildlife value orientations and attitudes toward recreational fishing was not supported
Tam (2013, Study 5: "Tam 1")[1]	Hong Kong	Undergradates (mean age = 20.55, SD = 1.51)	78	Individual Differences in Anthropomorphism Questionnaire (Waytz et al., 2010)	Dispositional Empathy with Nature Scale (Tam, 2013); a scale to measure public conservation behaviour (from the Environmental Attitudes Inventory (Milfont & Duckitt, 2010); a scale to measure private conservation behaviour (12 items adapted from past studies, such as Kaiser, Doka, Hofstetter, & Ranney (2003)	Anthropomorphism of animals, nonanimal natural entities, and nature, were associated with green behaviour frequency and environmental movement support (correlations ranging from r = 0.23 to r = 0.36); statistical support was reported for empathy to nature mediating the association between anthropomorphism and conservation behaviour (full mediation for anthropomorphism of natural entities and

						nature; partial for anthropomorphism of animals)
Tam et al. (2013, Study 1: "Tam 2")	Singapore	Undergraduates (mean age = 21; SD = 3.1; no age range given)	50	Amount of anthropomorphic content in pro-environmental posters generated by participants (who had been given no instructions to anthropomorphise in their posters)	Private Conservation Behaviour: bespoke items asking participants to indicate how likely they were to try green products and tell others about them; Support for Environmental Indicator of National Development (bespoke item)	Those grouped as having produced an anthropomorphic poster had stronger product use intention (d = 0.58) and support for one indicator of nation development (environmental impact; d = 0.72) than those who were grouped as having produced a less anthropomorphic poster, and these two outcomes were also correlated with degree of researcher-rated "human-ness" of natural entities on the posters (product use intention: r = .29; environmental impact: r = .30). As would be expected, the two groups did not differ in their support for the other three indicators of nation development (economic output, life expectancy, and life satisfaction)
Tam (2014, Study 1: "Tam 3")	Hong Kong	Undergraduates (mean age = 21.10; SD = 1.13)	239	Anthropomorphism of Nature Scale (Tam, 2013)	Efficacy: bespoke items asking participants to rate their understanding of the environmental crisis, how predictable they believe the future of the environmental crisis to be, and how predictable they believe the future of nature to be; Action Efficacy: bespoke items asking participants to rate their beliefs about how impactful and effective their actions can be in helping nature/resolving the environmental crisis, and how	Anthropomorphism of nature was correlated with perceived capacity to understand (r = .21) and predict (r = .16) the environmental crisis, action efficacy (r = .33), environmental movement support (r = .19), green behaviour frequency (r = .22), and product use intention (r = .26); statistical evidence was provided in support of a hypothesised model in which action efficacy and capacity to understand the environmental crisis were full mediators between anthropomorphism of nature and environmental movement support as well as green behaviour frequency, and a partial mediator between anthropomorphism and product use intention

					confident they feel in their ability to help nature; Public Conservation Behaviour: 10 items to assess for environmental movement participation, adopted from the Environmental Attitudes Inventory (Milfont & Duckitt, 2010); Private Conservation Behaviour: one measure asking participants how frequently they performed 12 green behaviours (adapted from previous studies such as Kaiser et al. (2003), and one bespoke measure in which participants were shown four "green" products on the market and asked how much they would like to try/to tell their family and friends about each product	
(Study 2: "Tam 4")	United States	General population (mean age = 32.03; SD = 12.37; range = 13 - 71) recruited via online jobs website	177	Anthropomorphism of Nature Scale (Tam, 2013)	Personal Action and Action Efficacy: bespoke items, in which personal action efficacy items were changed from "I" to "humans" to assess collective action efficacy (e.g., "What I/human beings do can be effective in protecting nature"); Public Conservation Behaviour: 10 items to assess for environmental movement participation, adopted from the Environmental Attitudes Inventory (Milfont & Duckitt, 2010); Private Conservation	Individual differences in anthropomorphism were correlated with environmental movement support (r = .18), green behaviour frequency (r = .18), intention to use green products (r = .16), personal action efficacy (r = .14), but not collective action efficacy. The authors reported statistical evidence in support of a hypothesised model in which personal action efficacy, but not collective action efficacy, is a full mediator between anthropomorphism of nature and all conservation behaviours (support for environmental movements; green behaviour frequency; intention to use green products)

					Behaviour: one measure asking participants how frequently they performed 12 green behaviours (adapted from previous studies such as Kaiser et al. (2003), and one bespoke measure in which participants were shown four "green" products on the market and asked how much they would like to try/to tell their family and friends about each product	
Tam (2015b, Study 1: "Tam 5")	Hong Kong	Undergraduates (mean age = 19.87; SD = 0.84)	126	Anthropomorphism of Nature Scale (Tam, 2013)	Bespoke measure of pro-environmental behaviours asking for frequency of each of eight behaviours; Values: Schwartz Values Questionnaire (Schwartz, 1992); Personality: BFI = Big Five Inventory (John, Donahue, & Kentle, 1991)	Mind attribution to nature was correlated with self-reported pro-environmental behaviours (r = .24), and improved the prediction of self-reported pro-environmental behaviours beyond personality traits and values (R^2 change = .16)
(Study 2: "Tam 6")	Hong Kong	University staff members (mean age = 32.82; SD = 8.39)	181	Anthropomorphism of Nature Scale (Tam, 2013)	Social Desirability Scale (Stöber, 2001); observed pro-environmental behaviour	Mind attribution to nature was correlated with observed pro-environmental behaviour (participants' donations to World Wide Fund for Nature Hong Kong; r = .21), and improved the prediction of observed pro-environmental behaviours beyond social desirability and demographic variables (R^2 change = .16)
(Study 3: "Tam 7")	Hong Kong	Undergraduates (mean age = 20.69; SD = 1.58)	62	Anthropomorphism of Nature Scale (Tam, 2013)	Bespoke measures of: pro-environmental behaviour intention and empathy toward nature (with two subcomponents: empathic concern and perspective-taking)	Mind attribution to nature was correlated with pro-environmental behaviour intention (r = .29). Results of a mediation analysis provided support for the empathy being a full mediator of the association between mind attribution to nature and pro-environmental behaviour intention

Tam (2019, Study 1: "Tam 8")	Hong Kong	University staff members (mean age = 32.86; SD = 8.37; range = 22 - 60)	176	Anthropomorphism of Nature Scale (Tam, 2013)	Two items to assess environmental guilt; two bespoke measures of participation in Earth Hour: 1. assessing intention to turn lights off during Earth Hour, and 2. assessing participation in Earth Hour in the past	Anthropomorphism of nature was found to be correlated with intention to participate in Earth Hour (r = 0.23), and there was support for environmental guilt as a mediator between these variables
Tam (2019, Study 2: "Tam 9")	Hong Kong	Undergraduates (mean age = 20.73; SD = 1.20; range = 18 - 25)	168	Anthropomorphism of Nature Scale (Tam, 2013); Individual Differences in Anthropomorphism Questionnaire (Waytz et al., 2010)	Bespoke scale of degree of emotional response to photos of environmental problems (nine emotions, including guilt, anger, and shame); three measures of pro-environmental behaviour intention: one measures of private-sphere pro-environmental behaviours (adopted from Tam, 2013); two measures of collective pro-environmental behaviours (the two subscales of the Environmental Action Scale; (Alisat & Riemer, 2015)	Anthropomorphism as measured by the Anthropomorphism of Nature Scale was correlated with pro-environmental behaviour intention (private-sphere: r = 0.24; participatory actions: r = 0.27; leadership actions: r = 0.35), and for the Individual Differences in Anthropomorphism Questionnaire, anthropomorphism of nature was the most consistent correlate with these variables and anthropomorphism of animals and inanimate devices less so. There was support for a mediational model in which environmental guilt mediated the association between anthropomorphism and pro-environmental behaviour intention
Tam (2019, Study 3: "Tam 10")	United Kingdom	General population (recruited from a participant panel website; mean age = 25.64; SD = 5.55; range = 18 - 70)	255	Anthropomorphism of Nature Scale (Tam, 2013)	A scale to assess participants' levels of 11 different emotions; two measures of pro-environmental behaviour intention: a private-sphere and public-sphere pro-environmental measure (adapted from Bain et al., 2016); one measure of actual behaviour, in which participants had the option to	Anthropomorphism was correlated with behaviour intention (private-sphere: r = 0.23; public-sphere: r = 0.27) but not actual behaviour (donation: r = 0.04); a mediation analysis supported environmental guilt as a mediator between anthropomorphism and both intention and donation

					donate to an environmental organisation	

[1]The authors chose a number system to refer to Tam's studies in the text for ease of reading.

Table 7

Summary of Findings from retained experimental studies

Authors	Country	Participant population	Sample Size (N)	Measure(s) of Anthropo-morphism	Measures of Outcomes/ Controlled Variables	Findings & Effect Sizes
Tam et al. (2013, Study 3: "Tam 11")[1]	Hong Kong	Undergraduates (mean age = 20.88; SD = 1.3; no age range given)	73	N/A	Connectedness to Nature: Connectedness to Nature Scale (Mayer & Frantz, 2004); Private Conservation Behaviour: bespoke items asking participants to indicate how likely they were to try green products and tell others about them; Support for Environmental Indicator of National Development (bespoke item)	Participants randomly assigned to read an anthropomorphised pro-environmentalism poster vs the control condition who read a non-anthropomorphised version had stronger product use intention (d = .48), and stronger support for country's adoption of an environmental impact indicator of nation development (d = .51); statistical evidence was provided in support of a hypothesised model in which connectedness to nature is a full mediator between anthropomorphism of nature and 1. product use intention; 2. environmental indicator support
Tam (2015a, Study 1: "Tam 12")	Online	Online study recruiting Americans on an online jobs site (mean age = 31.92; SD = 12.07)	314	N/A	Desirability of Control Scale (Burger, 2013); 10 items to assess for environmental movement participation, adopted from the Environmental Attitudes Inventory (Milfont & Duckitt, 2010); items to assess participants' likelihood of	Participants were randomised either to read an article about the environmental crisis referring to "Mr. Nature" (experimental condition) or "Nature" (control condition); while there was no main effect of Condition on the two outcomes (environmental movement participation and green

					performing 12 pro-environmental behaviours, adopted from previous studies (e.g., Tam (2013)	behaviour intention), desire for control was a moderator of the relationship between Condition and these outcomes, i.e., there was an interaction effect in which anthropomorphised language led to an increase in these outcomes for those with high desire for control and a decrease in those with low desire for control (η^2p = .02)
(Study 2: "Tam 13")	Hong Kong	Undergraduates (mean age = 20.45; SD = 1.68)	101	N/A	10 items to assess for environmental movement participation, adopted from the Environmental Attitudes Inventory (Milfont & Duckitt, 2010); items to assess participants' likelihood of performing 12 pro-environmental behaviours, adopted from previous studies (e.g., Tam (2013)	Participants viewed a poster with anthropomorphised content (experimental condition), compared with neutral content (control condition); while there was no main effect of Condition on the two outcomes (environmental movement participation and green behaviour intention), attachment style was a moderator of the relationship between Condition and these outcomes, i.e., there was an interaction effect in which anthropomorphised language led to an increase in these outcomes for those with strong attachment anxiety (without attachment avoidance) whereas the opposite was true for those with weak attachment anxiety (η2p = .17). Attachment avoidance did not have a moderating effect
Wang & Basso (2019, Study 2)	United States	General population, recruited from online jobs website (mean age = 33.44, SD = 11.25)	162	N/A	Two bespoke items to assess: how tasty and how enjoyable the meat would be from a restaurant depicted in a vignette; a bespoke	Participants randomised to read one of the anthropomorphic vignettes of pigs (depicting pigs' friendships with each other, or with humans) had lower attitudes toward meat (d = 0.76

					item to assess intention to purchase the meat product	and d = 1.06, respectively) and lower intention to purchase meat (d = 0.60 and d = 0.98, respectively) than in the control condition (a vignette in which pigs were depicted in a free-range scenario), and the two anthropomorphic conditions were not different from each other on these outcomes; statistical evidence was provided in support of a hypothesised model in which attitudes to meat mediated the effect of the experimental manipulation on purchase intentions (R^2 = 0.66)
(Study 3a)	United States	General population, recruited from online jobs website (mean age = 37.53, SD = 10.67)	111	N/A	Two bespoke items to assess: how tasty and how enjoyable the meat would be from a restaurant depicted in a vignette; a bespoke item to assess intention to purchase the meat product; four items to assess anticipatory guilt and responsibility from imagining eating the depicted meat product (how guilty, accountable, responsible and ashamed they would feel; adapted from (Ahn, Kim, & Aggarwal, 2014))	Participants randomised to read the anthropomorphic vignettes of pigs (depicting pigs' friendships with each other) had lower attitudes toward meat (d = 0.59) and lower intention to purchase meat (d = 0.45) than in the control condition; support was found for a mediation model in which being exposed to anthropomorphism led to increased anticipatory guilt, leading to less favourable attitudes toward eating meat, which led to lower purchase intentions (R^2 = 0.56)
(Study 3b)	United States	General population, recruited from online jobs website (mean age = 35.12, SD = 9.16)	108	N/A	Two bespoke items to assess: how tasty and how enjoyable the meat would be from a restaurant depicted in a vignette; a bespoke item to assess intention to purchase the meat product; four items to assess anticipatory guilt and responsibility from imagining eating the depicted meat product	No differences were found between those randomised to read the anthropomorphic vignette (depicting cows as having friendships with other cows) and those who read a control vignette, on attitudes toward meat or purchasing intentions

					(how guilty, accountable, responsible and ashamed they would feel; adapted from (Ahn et al., 2014))	
(Study 3c)	United States	General population, recruited from online jobs website (mean age = 38.93, SD = 13.05)	167	N/A	Two bespoke items to assess: how tasty and how enjoyable the meat would be from a restaurant depicted in a vignette; a bespoke item to assess intention to purchase the meat product; four items to assess anticipatory guilt and responsibility from imagining eating the depicted meat product (how guilty, accountable, responsible and ashamed they would feel; adapted from (Ahn et al., 2014))	Participants randomised to read one of the anthropomorphic vignettes of pigs (depicting pigs' friendships with humans) had lower attitudes toward meat (d = 0.76) and lower intention to purchase meat (d = 0.69) than in the control condition; support was found for two mediation models: 1. being exposed to anthropomorphism led to less favourable attitudes toward eating meat, which led to lower product use intentions; 2. being exposed to anthropomorphism led to increased anticipatory guilt, leading to less favourable attitudes toward eating meat, which led to lower purchase intentions (the model as a whole of both mediation paths accounting for R^2 = 0.67 of the variance)

222 [1]The authors chose a number system to refer to Tam's studies in the text given for ease of reading.

4. Narrative Synthesis

Tam's studies will henceforth be described according to the naming system used in Tables 6 and 7, for ease of reading.

Twenty-five studies were included in this review. They were carried out between 2004 and 2020, taking place across four continents and several countries: Hong Kong, Singapore, Australia and the Kingdom of Tonga, United Kingdom, Germany, Spain, Romania, and United States. One study did not report a country in which it took place, only reporting that data collection proceeded via an online jobs site (Tam 12).

Thirteen studies investigated a general population sample, one included primary school children, eight included undergraduates, one included university students more broadly, and two included university staff members. Results will now be presented separately for correlational studies in order to address the first question of this review, and experimental studies to address the second.

4.1 Study Quality

After the studies rated "Poor" in quality were excluded, the quality ratings for remaining studies were "Good" (12 correlational; one experimental) and "Fair" (six correlational; six experimental).

All of the correlational studies provided some measure of effect size, all but one specified their population clearly, and all but two were deemed to have stated a clear question. Thirteen studies were deemed to have partially fulfilled the criterion of using good quality measures for relevant variables (in all cases this was due to at least one measure not having its psychometric properties [reliability/validity] described). Five studies were deemed to have exclusively reported good quality measures with consistent implementation. Fifteen papers were deemed to have controlled for variables other than anthropomorphism in their analyses (through regression/mediation).

Of the experimental studies, all were deemed to have stated a clear hypothesis, specified their population clearly, provided a power analysis/reported effect sizes, and reported randomisation of participants into the experimental/control groups. No studies reported how participants were randomised, and whether therefore this was adequate. No studies reported on the baseline characteristics of the experimental/control groups, and therefore whether randomisation had achieved the desired effect. Six studies were deemed only to have partially reported good quality measures with consistent implementation, and two were deemed to have exclusively reported good quality measures with consistent implementation. Five studies conducted a check on whether the manipulation was likely to have influenced anthropomorphism.

4.2 Question 1: Is there a reliable association between anthropomorphism and pro-environmental variables?

Eighteen studies reported correlational analyses. One study did not find anthropomorphism to be associated with any expected measures (Riepe & Arlinghaus, 2014) and another found it not to be predictive of conservation behaviour when other variables were controlled for (Maguire et al., 2020); both studies were rated "Good" quality. The remaining 16 studies found anthropomorphism to be associated with all expected pro-environmental variables, with the exception of Díaz (2016; "Fair" quality) and Tam 4 ("Good" quality), who found support for the association of anthropomorphism with some, but not all, expected variables.

Of the 16 studies finding at least some support for associations between anthropomorphism and expected variables, six controlled for at least one other variable in analyses, either with mediation or regression analyses. Variables controlled for in regression analyses were as follows for "Good" quality studies: Apostol et al. (2013), controlling for gender, age pet ownership, education, residence, empathy to animals, empathic concern, and perspective-taking; Tam 5, controlling for personality traits and

values; Tam 6, controlling for social desirability and demographic variables. For "Fair" quality studies, variables controlled for in regressions were as follows: Díaz (2016), controlling for different kinds of anthropomorphism; Higgs et al. (2020), controlling for gender, age, ethnicity, religion, eating orientation, education, working with animals, and being a scientist; Knight et al. (2004), controlling for age, gender, pet ownership, meat eating, political stance, and living area. Nine studies controlled for variables with mediation analyses (see Section 4.2.1, below).

Correlational studies measured dispositional anthropomorphism, i.e., individuals' natural tendency to perceive non-human entities as having humanlike characteristics. All correlational studies (except for Tam 2, to be discussed below) measured mind attribution, i.e., perceiving nature/species to have mental experiences and capacities. One measure of mind attribution is the Anthropomorphism of Nature Scale (ANS; Tam, 2013), in which respondents are asked to what extent nature has a mind of its own, free will, consciousness, intentions, and emotional experience. This scale has been reported to have good internal consistency and predictive validity (Tam, 2013). Eight studies by Tam used the ANS (Tam 3 – 10). These were all rated "Good" quality and controlled for other variables. These studies found that mind attribution to nature is associated with pro-environmental behaviour intention (five studies), action efficacy (two studies), and environmental movement support (two studies). Four studies found mind attribution to nature to be associated with self-reported pro-environmental behaviour. As for observed pro-environmental behaviour (in the form of donations made by participants during the study), whereas one study found mind attribution to be associated with this (Tam 6), one did not find evidence for this as a main effect (Tam 10; but see Section 4.2.1 for a mediation analysis that revealed an association).

Tam 9 used another measure alongside the ANS: the Individual Differences in Anthropomorphism Questionnaire (IDAQ; Waytz et al., 2010), which looks at people's beliefs about whether a target has five different mental states/capacities ("a mind of its own", "free will"; "consciousness", "intentions", and "can experience emotions", p. 229). The IDAQ applies these states to devices (e.g., a computer), nature (e.g., the ocean), and animals (e.g., an insect). This measure has demonstrated good construct validity and reliability (internal consistency and temporal stability; Waytz et al., 2010). Tam 9 found the IDAQ-nature and the ANS to have the highest correlations with pro-environmental behaviour intention, and IDAQ-animals/devices less so. Correlations were found to be high between the IDAQ-nature and the ANS ($r = 0.78$) and low between the ANS and IDAQ-animals ($r = 0.35$)/IDAQ-devices ($r = 0.42$), suggesting that the IDAQ-nature and the ANS might measure the same construct. This paper also revealed a three-factor solution to the IDAQ according to its proposed subscales, providing statistical support that the tendency to attribute a mind to one kind of target is not necessarily associated with mind attribution to another kind.

The IDAQ was used by another study (Tam 1, rated "Good" quality which found IDAQ-nature and IDAQ-animals both to be associated with green behaviour frequency and environmental movement support.) The IDAQ was adapted by two other studies (rated "Good" quality) in which items were reworded to relate to wildlife (Manfredo et al., 2020; e.g., whether wildlife "have intentions", p. 3) and a specific animal species - whales (Maguire et al., 2020; e.g., "to what extent do whales have free will", p. 110). The first found a significant role for mind attribution to wildlife in a mediation model (see Section 4.1.2). The second did not find mind attribution to whales to be associated with conservation behaviour when other variables were included.

Another measure used by studies to assess mind attribution to animals was the Belief in Animal Mind Questionnaire (BAMQ; Hills, 1995), which was used by Apostol et al. (2013); Hawkins and Williams (2016); Higgs et al. (2020); and Knight et al. (2004). The BAMQ asks four questions about belief that most animals are aware, can think and solve problems, and can feel emotions, and has high internal consistency ($\alpha = .90$; Hills). Of these studies the highest quality (Apostol et al., 2013; "Good" quality), showed mind attribution to animals to be associated with attitudes toward animals when the researchers controlled for other variables. The three remaining papers ("Fair" quality) found those with higher mind attribution to animals to be less accepting of behaviours toward animals that would entail harming or using them in some way.

Two studies analysed mind attribution to animals by adapting the Attributes Questionnaire (Herzog & Galvin, 1997), which the authors validated through factor analysis and has been shown to have high internal consistence (α = .94; e.g., Díaz, 2016). Riepe and Arlinghaus (2014; "Good" quality) analysed mind attribution to nine animals (collapsed across all species) by assessing beliefs in these animals' capacity to feel fear, pain, and suffering, and did not find support for mind attribution's association with attitudes toward recreational fishing. Díaz (2016; "Fair" quality) assessed three subcomponents of mind attribution (presence of consciousness, ability to suffer/feel pain, and ability to experience emotions) and analysed them separately. They also measured another attribute that they classed as a kind of anthropomorphism: animals' worthiness of moral consideration. When collapsed across 13 species, the three mind attribution subcomponents, combined with participants' ratings of affection toward animals, predicted participants' beliefs in animals' worthiness of moral consideration. When the three mind attribution subcomponents, affection, and moral consideration were entered into a model to predict behaviour intention (to become vegetarian / vegan), only moral consideration and affection explained unique variance in the model.

Finally, Tam 2 ("Fair" quality) did not use a questionnaire-based measure of anthropomorphism, but rated the amount of anthropomorphic content in pro-environmental posters generated by participants. Examples of anthropomorphic posters generated by participants showed physical elements similar to humans (e.g., a drawing of the Earth depicted with eyes and a mouth) and those that may have implied mind attribution (the Earth expressing emotion through frowning).

4.2.1 **Mediation.** Nine correlational studies conducted mediational analyses to investigate variables that might mediate the association of anthropomorphism with pro-environmental variables, all rated "Good" quality. Manfredo et al. (2020) reported a mediation analysis in which mind attribution to wildlife reduced support for lethal management of carnivores largely via mutualism values. Riepe and Arlinghaus (2014)'s study did not find support for mind attribution to trout as a mediator of value orientation toward wildlife and attitudes toward fishing.

Tam's correlational studies (1; 3 – 4; 7 – 10) found the following mediations: empathy to nature as a mediator between mind attribution to nature and animals (separately) and conservation behaviour; empathy to nature as a mediator between mind attribution to nature and pro-environmental behaviour intention; environmental guilt as a mediator between mind attribution to nature and intention to engage in pro-environmental behaviour; environmental guilt as a mediator between mind attribution to and pro-environmental behaviour; environmental guilt as a mediator between mind attribution to nature and both public/private-sphere pro-environmental behaviour intention and actual behaviour (donation).

4.3 Is there reliable evidence that manipulating anthropomorphism leads to pro-environmental outcomes?

Different methods were used for manipulating anthropomorphism among the seven experimental studies. Tam 11 manipulated anthropomorphism by showing participants either an anthropomorphised or a non-anthropomorphised poster depicting nature (generated by participants in Tam 2; e.g., a cartoon of the Earth with a human face, frowning). These same posters were shown to participants in Tam 13. Participants in Tam 12 read an article about the environmental crisis describing nature as "Mr. Nature" and using personal pronouns, whereas the control article used "Nature" and impersonal pronouns instead. In the four studies by Wang and Basso (2019), participants either read an anthropomorphic vignette of farm animals (pigs in studies 2 and 3a, and 3c; cows in 3b) which entailed describing them as having friendships with each other or with other humans, or read a control condition (describing the animals in a free-range scenario).

One experimental study was rated "Good" quality (Tam 11), and found the manipulation to lead to stronger product use intention and stronger support for the nation's adoption of an environmental impact indicator of development. One of the remaining six experimental studies (all rated "Fair" in quality) did not find the expected effect of anthropomorphism on attitudes toward eating meat and intention to

purchase meat (Wang & Basso, 2019, Study 3b). This study depicted anthropomorphism of cows, whereas the remaining studies by these authors depicted anthropomorphism of pigs and did find the expected effect of the manipulation in leading to lower attitudes toward eating meat and lower intention to purchase meat. The remaining two studies by Tam (12 & 13) did not find a main effect of the manipulation on pro-environmental behaviour and behaviour intention, but did find an effect of the manipulation when attachment anxiety in the absence of attachment avoidance was a moderator and when desire for control was a moderator, respectively.

***4.3.1 Mediation*.** Tam 11 conducted a mediational analysis (rated "Good" quality). These authors found support for a model in which connectedness to nature acts as a full mediator between anthropomorphism of nature and 1. product use intention; 2. environmental indicator support.

The three studies by Wang & Basso (2019) that found positive main effects of anthropomorphism found additional support for the following mediation models: the effect of anthropomorphism on the intention to purchase meat was mediated by attitudes to eating meat (Study 2); the same model, but with anticipatory guilt leading to lower attitudes toward meat (Study 3a); and both of these models (Study 3c).

5. Discussion

This study is the first to take a systematic survey of the literature on anthropomorphism and its association with pro-environmental outcomes. There are experimental studies of at least adequate quality that agree in broad terms that manipulating anthropomorphism gives rise to expected changes on measured variables, implying that this could be a beneficial tool in some circumstances. The included literature was remarkably broad in terms of the countries represented, which enhances confidence in the generalisability of the findings across cultures.

The highest quality experimental study (Tam 11) provides evidence that inducing anthropomorphism can strengthen pro-environmental behaviour intention (intention to use green products) and attitudes toward environmental government policies (stronger support for an environmental impact indicator of nation development) via connectedness to nature. Guilt was another mediator that was reported by both experimental and correlational studies (of mixed quality). Tam 8 – 10 (rated "Good" quality) found correlational support for environmental guilt as a mediator between mind attribution to nature and behavioural intention/observed behaviour, and two of Wang and Basso's (2019) experimental studies (3a and 3c, rated "Fair" quality) reported statistical support for a mediation model in which mind attribution to animals led to anticipatory guilt about eating meat, which led to less favourable attitudes toward eating meat and then to lower intentions to purchase meat. Empathy received support as a potential mediator from "Good" quality studies, although these were all correlational in nature. Apostol et al. (2013) showed empathy to animals to be the highest predictor of positive attitudes toward animals, above mind attribution to animals. Tam, in two studies, found empathy to nature to mediate the association between mind attribution to animals/nature and conservation behaviour, and between mind attribution to nature and pro-environmental behaviour intention (Tam 1 & 3, respectively).

These three concepts are related in a variety of ways. For one, Tam (2019) notes that connectedness, empathy, and guilt are normally experienced in interpersonal relationships. Perceiving non-human species and nature as a whole to be humanlike may therefore invite these responses. In addition, these interpersonal responses may all relate to the desire to treat others in a moral way; believing one has caused another harm leads to guilt (Zeelenberg & Breugelmans, 2008), which requires empathic capacity (perspective-taking; Leith & Baumeister, 1998), and nature connectedness may allow more of the natural world to be encompassed within one's moral circle (Crimston, Bain, Hornsey, & Bastian, 2016). It seems reasonable that any experimental manipulation of anthropomorphism that influences one of these will influence the other two, yet no experimental study controlled for the other two variables in mediation analyses. It would be illuminating for future experiments to look at guilt, empathy, and nature connectedness together to determine whether they are all influenced by anthropomorphism or

whether one takes precedence, as well as to investigate the relative strength of each as a mediator between anthropomorphism and other pro-environmental outcomes. Another analysis of interest would be to consider the potential moderating role of these variables. While it appears these variables can be experimentally induced, they can also be considered as dispositional characteristics. This raises the question of whether the effectiveness of each as a mediator depends on participants' baseline disposition.

It is of note that such diverse ways of inducing anthropomorphism seemed to influence an outcome of interest. Tam 12 found that merely adding "Mr." to the description of nature had a discernible influence on pro-environmental outcomes. Although this could be considered a kind of anthropomorphism in terms of ascribing a human pronoun to nature which would imply similarity of other characteristics, it seems like a less explicit way of inducting anthropomorphism than the other experiments, which seemed to describe more explicitly behaviours that implied mental capacities such as motivations and emotions (e.g., animals forming friendships; a picture of the world frowning). It is therefore notable that this was one of two studies that did not find a main effect for anthropomorphism, and that the effect on pro-environmental depended on participants' levels of desire for control. It may be that this 'weaker' from of anthropomorphism, which does not directly depict humanlike behaviours or characteristics, is what was responsible for a less robust finding. It is also important to consider the degree to which the pronoun "Mr." would have been perceived as a realistic depiction of nature's similarity to humans, and whether a lack of realism may account for some of the unintended effects of the manipulation for some participants. Regardless of the reasons, these results serve as a reminder that anthropomorphism is a tool that could be counterproductive for environmental campaigns in some cases.

It is also interesting that the suite of studies by Wang and Basso (2019) showed anthropomorphism of pigs to consistently lead to pro-environmental outcomes, whereas the same was not found with anthropomorphism of cows. Riepe and Arlinghaus (2014) was the only correlational study not to find any association between anthropomorphism and pro-environmental variables (in this case, mind attribution to trout did not to predict variance in attitudes toward recreational fishing). These results highlight that more work is required to determine the species that may not benefit from anthropomorphic depictions, and the reasons why.

5.1 Theoretical Integration

No study explicitly analysed anthropomorphism through the lens of established theories of behaviour change; doing so might shed light on its mechanisms of action. As discussed in the introduction, the TPB (Ajzen, 1991) is an important model with empirically proven predictive power for a range of behaviours. It is notable that this theory was very seldom referred to in the studies despite many of its variables being represented across the studies as a whole (attitude toward the behaviour, self-efficacy, behavioural intention, and actual behaviour). Studies that conducted mediation analyses can be particularly illuminating here. For example, three experimental studies by Wang and Basso (2019, Studies 2, 3a, and 3c; all "Fair" quality) reported that the effect of mind attribution to animals on the intention to purchase meat was mediated by attitudes to eating meat; this is as the TPB would predict. Tam 3 and 4 ("Good" quality) also found the association between mind attribution to nature and attitudes toward conservation behaviour/behaviour intention/behaviour frequency to be mediated by action efficacy. Although linked to a different theory in the paper, action efficacy is conceptually related to the TPB's behavioural beliefs, as both constructs entail beliefs about the consequences of undertaking a particular behaviour. As behavioural beliefs are held by the TPB to influence attitudes toward the behaviour (and, in turn, behaviour intention and actual behaviour), the results of Tam 3 and 4 align with what the TPB would predict.

The role of empathy, nature connectedness, and environmental guilt may also be accommodated within the TPB. In the reviewed studies, these mediator variables were found to be associated with TPB-related variables (e.g., nature connectedness explaining the link between mind attribution to nature and behavioural intention as well as attitude toward a pro-environmental action; Tam 11). The piecemeal

treatment of these variables, however, does not allow for the relevance of theories such as the TPB in this field to be examined, which would require simultaneous inclusion of its constructs in a model to allow paths of direct and indirect influence to be discerned. One neglected construct in the studies is that of norms. Moral norms in particular might be beneficial to include in future studies, both for the aforementioned association of some of the mediator variables with moral concern, as well as the suggestion of Fishbein and Ajzen (2011) that moral norms be included in models when predicting behaviours that have a strong moral component (such as pro-environmental behaviours; cf. Steg & Nordlund, 2018).

5.2 Limitations of the literature

No experimental study reported the effects of manipulating anthropomorphism on actual behaviour, which is an important gap for future experiments to fill. Further work is required to develop more understanding of the specific effects of anthropomorphism. The experimental studies in this review generally did not specify in detail the kind of anthropomorphism they intended to manipulate, in contrast to the correlational studies which clearly focused on mind attribution to animals/wildlife/nature. It is notable that such an array of methods for inducing anthropomorphic perceptions led to pro-environmental outcomes – in keeping with the array of mediators and pro-environmental variables found to be associated with anthropomorphism in the correlational studies – but more clarity in experiments about the particular type of anthropomorphism being targeted will help with understanding the mechanisms of action. A related point is about matching anthropomorphism to specific outcomes. Maguire et al. (2020) found that mind attribution to whales was not uniquely predictive of conservation behaviour, but as the former was specific to whales and the latter was a measure of generic conservation behaviour (with only one item out of thirteen pertaining to whales), the lack of an expected finding may be due to a mismatch between the specificity of the measures. Further research clarifying the contexts in which anthropomorphism may affect pro-environmental outcomes in a broad or narrow way would be beneficial. It may be, for example, that mind attribution to nature as a whole is associated with a similarly generic pro-environmental attitudes and behaviours, whereas mind attribution to specific types of animal may relate to a more confined set of variables that relate to those species. Indeed, Manfredo et al. (2020) found mind attribution to wildlife as a whole to be related to attitudes about lethal management of carnivores.

While the majority of correlational studies were considered high quality, the main detractor from quality was a lack of controlling for other variables in analyses, reducing the confidence in results showing anthropomorphism to be associated with other variables. Gender, which was not always controlled for in analyses, is an important variable for future studies in this area to include given its association with attitudes toward animals and concern/action with regard to animal welfare (Herzog, 2007), anthropomorphism of nature (Tam, 2014), and pro-environmentalism more broadly (Gifford & Nilsson, 2014). There is also evidence that gender differences in empathy mediate gender differences in attitudes toward animal exploitation (Graça, Calheiros, Oliveira, & Milfont, 2018). There may be some benefit to controlling for age in analyses given its associations with pro-environmentalism (Gifford & Nilsson, 2014); however, compared with gender it appears to have a less consistent association with empathy and pro-environmental outcomes (e.g., Tam, 2013).

While it is encouraging that a diversity of methods for manipulating anthropomorphism led to pro-environmental outcomes, and that associations were found when anthropomorphism and other variables were measured in a multitude of ways, building a formal sense of average effect size through meta-analysis is rendered impossible for these very reasons. The use of bespoke items and adapted questionnaires to measure constructs is also a clear pattern among included studies, and measures were often included without any accompanying statements about their validity or reliability. The present study has attempted to mitigate these challenges by focusing on higher quality papers, but future reviews will be better placed to draw more definitive conclusions about a wider range of associations between anthropomorphism and pro-environmental variables if studies address these principal limitations.

Many of the studies included in this review were from the same research group (Tam and colleagues). These papers were high quality, but it is important to acknowledge that some bias may be introduced in the review by the preponderance of studies from one subset of individuals, where research interests may home in on a particular aspect of anthropomorphism and pro-environmentalism. Nonetheless, this provided some benefit with regard to the consistent use of measures allowing for comparisons across studies, and this research group did cover a breadth of areas, including empathy, guilt, nature connectedness, efficacy, and the influence of dispositional traits on the effects of anthropomorphic manipulations. The review likely introduced some bias with regard to its systematic search on two additional counts. First, only English-text articles were included, which did not allow results from non-English language publications to be considered. Second, while some of the databases that were searched do include grey literature such as conference abstracts, the fact that the review did not entail a more systematic search for any unpublished works introduces the potential for publication bias.

5.3 Conclusions

This review summarises the highest quality evidence for anthropomorphism of non-human species and its associations with pro-environmental variables. There is relatively good evidence that anthropomorphism increases connectedness to nature and that this in turn increases other pro-environmental attitudes and behaviours. Empathy and guilt have also received consistent support for their association with anthropomorphism, although experiments are needed to confirm whether the former is causally associated with anthropomorphism and has any mediating role. The findings suggest that anthropomorphism may be a helpful tool for achieving public support for conservation in some circumstances, although more evidence is needed as to the limitations of this strategy in terms of which species or elements of nature may be associated with pro-environmental outcomes when they are the focus of anthropomorphism, and whether anthropomorphism may backfire for some people, when presented in a certain way. Future work is needed to clarify any differential benefit of manipulating anthropomorphism in relation to pre-existing levels of dispositional nature connectedness, guilt, and empathy toward nature. To improve the quality of studies for any future reviews, correlational studies should focus on statistically controlling for correlations in relation gender and possibly age, and experiments should employ manipulation checks.

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