A cross-cultural comparison of the link between modernization, anthropomorphism and attitude to wildlife.

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Abstract: Anthropogenic pressure has significantly increased in the last decades, often enhancing conflicts at the human-wildlife interface. Therefore, understanding people's value orientations, attitudes and behavioural intentions towards wildlife is a crucial endeavor to reduce the occurrence of conflicts between humans and wildlife. Previous research in the USA has shown a consistent link between modernization and increased anthropomorphism (i.e., the tendency to attribute human mental or physical characteristics to other entities), leading to positive changes in value orientations, attitudes and behavioural intentions towards wildlife. In this paper, we aimed to address whether this link is also present in other cultures, by testing participants (N=741) in five different countries (Brazil, Indonesia, Malaysia, Mexico and Spain). Our study showed that while the positive link between anthropomorphism, positive attitudes and behavioural intentions towards wildlife is universal, the link between modernization and anthropomorphism is culturally mediated. In some countries (Indonesia, Malaysia, Spain), modernization increased anthropomorphism, while in others modernization predicted no differences (Brazil) or even a decrease in anthropomorphism (Mexico), ultimately deteriorating individuals' attitude and behavioural intentions towards wildlife. These results call for caution when generalizing findings from western industrialized countries to inform conservation policies worldwide.

Keywords: modernization; anthropomorphism; domination; mutualism; attitude; wildlife1.

1. Introduction

Anthropogenic pressure on the environment (i.e., any human activity that may have a direct or indirect impact on ecosystems, like hunting, logging or pollution derived from industry) has significantly increased in the last decades, often enhancing conflicts at the human-wildlife interface, with consequences for human safety, disease transmission and biodiversity loss, just to name a few (e.g., [1–3]). Therefore, decreasing the occurrence of these conflicts appears a major endeavor for politics and science [4,5]. One way to reduce the occurrence and/or intensity of conflicts between humans and wildlife is to improve people's attitude toward wildlife, for instance through education programs that increase environmental knowledge [6,7]. However, other factors might also affect human attitude toward wildlife. Domination orientations, for instance, emphasize the existence of a hierarchical division between human and non-human animals, and are thought to lead to a utilitarian attitude to wildlife, in which the environment is mainly managed to increase human welfare (e.g., [8,9]). Males and older people, for instance, are more likely to have

domination orientations than females and younger individuals [10]. In contrast, mutualism orientations stress how humans and other animals are part of the same socio-ecological world, leading to positive feelings, social attachment and a more positive attitude toward wildlife [11–13]. Mutualism orientations, for instance, are thought to be to be higher in females and in individuals living in more urban areas, as compared to males and individuals from more rural areas [10].

Recently, researchers have proposed that an increase in modernization, a broad term including economic wealth, urbanization and formal education, might have caused a change in the relationship between humans and wildlife, by altering human orientations (i.e., domination or mutualism), attitude and behaviours toward wildlife (see [9,12–14]). In particular, modernization has led people in post-industrial countries to experience increased loneliness and social isolation [16], but also less frequent encounters with wildlife and thus a more benign and less conflictive association with animals (e.g. through pet ownership; see [12,17]). According to this hypothesis, the tendency to attribute human mental or physical characteristics to other entities (i.e., anthropomorphism), further fostered by an affective relationship with pets, would have enhanced human empathy and perception of similarity with other species (see [18,19]). In turn, this would have led humans to switch from domination to mutualism orientations, and to more positive attitudes and behaviours toward animals [9,11,12,14,15,19–21].

In the USA, individuals scoring higher in urbanization, income and education were more likely to attribute free will, consciousness or ability to experience emotions to wildlife, and to describe humans and other species as being part of the same family, sharing the same rights [19]. These participants also had a more positive attitude toward wildlife in case of conflict, more likely rejecting the idea of using animals for their own benefit [19]. These results are in line with other studies showing that humans are more willing to invest in the conservation of species that are phylogenetically closer to humans and thus more likely to be anthropomorphized [22–26]. In other countries, the link between anthropomorphism, mutualism and/or better attitude toward animals is also relatively well established (see [27]). Anthropomorphism, for instance, predicted students' intentions to become vegetarian and vegan in Spain [28], worse attitudes toward meat consumption in the USA [29], and a better attitude toward several species in the UK [30]. Anthropomorphism also correlated to mutualism and positive attitudes toward animals in Romania [31], and to positive attitudes toward nature in Singapore [32,33] and Hong Kong [34]. These effects are evident despite important inter-individual differences in anthropomorphism, which are linked to individuals' gender [35,36], age [37] and emotional attachment to pets [38]. In Germany, in contrast, anthropomorphism had little effect on attitude toward fishing, although mutualism was linked to a negative perception of these practices [39]. Besides the work conducted in the USA, however, little is known about the link between modernization and anthropomorphism. In particular, it is not clear whether higher modernization generally predicts an increase in anthropomorphism across countries, with positive changes in orientations and attitudes.

In this study, we aimed to analyze the complex relationship between modernization, anthropomorphism, mutualism/domination orientations and attitude towards wildlife, by using a cross-cultural approach. We built on the work by Manfredo and colleagues [19], adapting it in the following ways. First, we conducted research in five countries in three continents (i.e., Brazil, Indonesia, Malaysia, Mexico and Spain), using the same methodology to allow a reliable cross-cultural comparison. Second, we assessed several aspects of modernization beyond the ones used by Manfredo and colleagues [19] (i.e., urbanization, income and formal education), also including questions about participants' use of technologies, sociality and relationship with animals (see Methods and Appendix B for more details). Finally, we included a new set of questions to assess participants' attitude toward wildlife, and directly tested its link to anthropomorphism, mutualism and domination.

We predicted that modernization would be linked to an increase in anthropomorphism, but that this effect would be culturally mediated, varying across countries (Prediction 1; Table 1). We further predicted that higher anthropomorphism would be linked to lower domination and higher mutualism (independently of participants' country; Prediction 2; Table 1). Finally, we predicted that participants with lower domination and higher mutualism would show more positive attitudes towards wildlife, independently of their country (Prediction 3; Table 1).

2. Materials and Methods

2.1. Ethics.

Participation was voluntary and completely anonymous. Informed consent was obtained from subjects before testing started. Participants were informed about the purpose of the study and were able to withdraw their participation at any time.

2.2. Participants.

We recruited 741 participants across five countries (Brazil, N=156, Indonesia, N=248, Malaysia, N=118, Mexico, N=111, Spain, N=108), for details see Appendix A. We started testing participants in Indonesia (N=248) and Spain (N=19) with a printed version of the questionnaire that participants filled in person. However, soon after we started data collection in Spain we had to stop direct interactions with people due to the outbreak of the Covid-19 global pandemic. We therefore switched to an online version of the questionnaire using the ethnographic software Ethnoap. Online recruitment proved to be difficult, but our sample sizes are still in line with other studies on cross-cultural variation in attitude/behavior to wildlife (e.g. [28,39,40]). Comparing the two Spanish groups (which were the only countries in which we tested participants both online and in person) revealed no significant differences in their responses (Table 2: for all six comparisons, $p > 0.05$), and therefore we included all participants in the subsequent analyses.

Participants identified themselves as females (N=394, mean age±SD=28.22±13.34, range=17-78) or males (N=240, mean age±SD=29.57±13.96, range=17-79). For more demographic information about the participants, please see Appendix A and B. In Indonesia, participants were opportunistically recruited in the Bira Bonto Bahari beach-road area (N=100), and at the Hasanuddin University by the 6th author (N=145). In Spain, participants were recruited by the 1st author (i.e., in person: by distributing the printed version before the beginning of lectures at the University of Seville, Spain; online: by distributing the Ethnoap link through the online-class platform before the beginning of lectures). In Malaysia, participants were recruited by the 4th author, and in Brazil and Mexico by the 3rd and 5th author through social media, in both urban and rural communities (i.e., specifically advertising the questionnaire to acquaintances living in both kinds of communities). Although we aimed to recruit a sample representative of the general population, our final sample was biased towards younger individuals with higher formal education (see Appendix A and B for details).

2.3. Questionnaires.

We used the questionnaire designed and validated by Manfredo and colleagues [19] to measure anthropomorphism, domination and mutualism orientations. First, we assessed participants' anthropomorphism with 5 statements (e.g., "Animals have free will") that could be rated on a 5-point agreement scale (from "strongly disagree" to "strongly agree"). These measures were combined into an individual modernization score between 0 and 1 (i.e., minimum to maximum level of anthropomorphism; see Appendix B). Second, we assessed participants' domination orientation with 10 statements (e.g., "Humans should manage fish and wildlife populations so that human benefit") rated on a 5-point agreement scale. Similarly, we assessed participants' mutualism orientation, by using 10

statements (e.g., "Hunting is cruel and inhumane to the animals") rated on a 5-point agreement scale. These measures were combined into a domination score and a mutualism score, both between 0 and 1 (i.e., minimum to maximum domination and mutualism levels; see Appendix B). Internal consistency for these three measures was acceptable/good, with Cronbach's alpha ranging from 0.72 for anthropomorphism to 0.85 for mutualism.

We further assessed other possible factors that might be linked to participants' anthropomorphism, mutualism and domination orientations. First, we assessed participants' attitude towards wildlife with 4 questions rated on a 5-point agreement scale (e.g., "Animals are a pest messing up the place where I live"; see Karimullah et al., in review). Responses were then combined into a single score from 0 to 1 (i.e., most negative to most positive attitude towards wildlife). Second, we measured different aspects of participants' degree of modernization, including their (i) individual income, (ii) level of formal education, (iii) modern experience with animals (e.g., "Have you ever visited a zoo, a natural reserve or a similar place?"), and (iv) access to technologies (e.g., use of social media). Please note that the concept of "modernity" (especially in relation to experience with animals) has a neutral connotation, and is simply used to refer to all those human-animal interactions that are more likely to occur in "modern", i.e. more urbanized contexts, where natural encounters with wild animals are less likely. Third, we assessed pet-ownership dynamics (i.e., ownership and affection to pets) with a score ranging from 0 to 1 (i.e., lowest to highest affection to pets), based on their response to 3 yes-or-no questions (e.g., "Do you own any animal?"). Fourth, we assessed participants' sociality (i.e., frequency of social interactions) based on 9 open questions measuring different aspects of sociality (e.g., "How many times do you hang out in an average week?"). The final score ranged from 0 to 9 (i.e., lowest to highest sociality). Fifth, we assessed participants' idiocentric and allocentric tendencies using a validated questionnaire with 16 statements (as in [41,42]), like "I would rather depend on myself than others", rated on a 5-point agreement scale. Finally, we collected demographic information with open questions on participants' age, gender and dietary preferences (i.e., being vegetarian or vegan). For more details on how each score was calculated, please see Appendix B.

2.4. Data analysis.

We used linear mixed models and generalized linear mixed models [43–45] with the glmmTMB package (version 1.0.16 [45]) in R [44]. We run four pairs of full-null models. In Model 1 (M1), we aimed to test whether modernization predicted higher anthropomorphism, and whether country mediated this relationship (see [19]). The anthropomorphism index was our dependent variable, which varied between 0 and 1 and was modelled with a beta distribution. As test predictors in M1, we included the two-way interaction of modernity with country. Moreover, we included as test predictors the idio-allocentric, sociality and pet-ownership indexes, and whether participant had a vegetarian/vegan diet (as binomial predictor). Participants' age and gender were included as controls.

In Models 2a and 2b, we aimed to test whether higher anthropomorphism predicted lower domination (M2a) and higher mutualism (M2b), and whether this held true across countries. Our dependent variables were domination (in M2a) and mutualism (in M2b), which both varied between 0 and 1 and were thus modelled with a beta distribution. In both models, we included the two-way interaction of anthropomorphism with country as test predictors, and as controls all the other controls and predictors that had been included in M1 (i.e., modernity, idio-allocentric, sociality and pet-ownership indexes, vegetarian/vegan diet, participants' age and gender).

In Model 3 (M3), we aimed to test whether higher mutualism and lower domination predicted a more positive attitude toward wildlife, and whether this was true across countries. Our dependent variable was attitude toward wildlife, which also varied between 0 and 1 and was modelled with a beta distribution. As test predictors we included the two-

way interaction of domination with country, as well as the two-way interactions of mutualism with country. As controls we included, as above, all the controls and predictors that had been included in the previous models (i.e., anthropomorphism, modernity, idio-allocentric, sociality and pet-ownership indexes, vegetarian/vegan diet, participants' age and gender).

After removing missing data, we had a total of 574 data points for M1, M2a and M2b, and 571 for M3. Before running the models, we *z*-transformed all continuous predictors to facilitate model convergence and interpretation of model coefficients. Dependent variables including 0s and/or 1s were previously transformed as suggested by Smithson & Verkuilen [46]. We used likelihood ratio tests to compare full models containing all predictors with null models containing only control predictors and random factors. When full models significantly differed from null models, likelihood ratio tests were conducted to obtain the p values for each test predictor via single-term deletion using the R function drop. When models included two-way interactions, also the main terms were included, and if the interaction was not significant, the model was re-run only including the main terms (e.g., M2a). Post-hoc comparisons were then conducted using Tukey tests for significant categorical predictors or interpreting the slope for continuous predictors. We added significant test predictors of the former full models (e.g., M1) as controls in the following models (e.g., M2), to account for the fact that the same measures could be used as dependent or independent variables in different models (e.g., we tested if anthropomorphism was predicted by modernization, but we also tested whether anthropomorphism predicted domination). If modernization predicted anthropomorphism in M1, for instance, in M2 we tested whether anthropomorphism predicted domination by also including modernization as a control, so that the effect of anthropomorphism on domination could be assessed while controlling for modernization. We detected no overdispersion or convergence issues in any of the models presented. To rule out collinearity, we determined the VIFs, which were acceptable (maximum VIFs across all models = 4.45).

3. Results

In M1 we tested whether modernization predicted higher anthropomorphism, and whether country mediated this relationship (see Figure 1). The full and null models significantly differed (GLMM: $\chi2$ =107.81, df=13, *p*<0.001; Table 3), showing a significant effect of the 2-way interaction (modernity-country: *p*=0.046). In particular, modernization predicted an increase in anthropomorphism in all countries, except for Latin American countries (i.e., Brazil, where it had no effect on anthropomorphism, and Mexico, where higher modernization was linked to lower anthropomorphism). Moreover, modern pet-ownership dynamics (*p*=0.006) and having a vegetarian/vegan diet (*p*=0.012) were linked to higher anthropomorphism.

In M2a and M2b we tested whether anthropomorphism predicted lower domination (M2a) and higher mutualism (M2b), and whether this held true across countries. In M2a, the full and null models significantly differed (GLMM: $\chi2$ = 150.54, df=9, *p*<0.001; Table 3). Domination was higher when anthropomorphism was lower (*p*<0.001), and it differed across countries *(p*<0.001*)*, being generally higher in Asian countries (i.e., Malaysia and especially Indonesia), intermediate in Spain and lowest in South America (i.e., Mexico and especially Brazil). In M2b the full and null models were significantly different (GLMM: $\chi2$ = 248.49, df=9, *p*<0.001; Table 3), with the 2-way interaction of country and anthropomorphism significantly predicting mutualism (*p*< 0.001). In particular, higher anthropomorphism predicted higher mutualism across all countries, especially in Malaysia (see Figure 2).

In M3 we tested whether higher mutualism and lower domination predicted a more positive attitude toward wildlife, and whether this was true across countries. The full and null models significantly differed (GLMM: $\chi2$ = 206.77, df=14, *p*<0.001; Table3), showing a significant effect of both 2-way interactions (domination-country: *p*= 0.043, see Figure 3; mutualism-country: *p*<0.001, see Figure 4). In particular, higher domination predicted

256 worse attitude in all countries, but Malaysia, while higher mutualism predicted better at-
257 titude in all countries, and especially in Malaysia.

258 *Figures, Tables and Schemes*

259 **Table 1.** Predictions of our study, models used to test them, and whether they were confirmed.

Prediction	Model	Confirmed?
1. Modernization is linked to higher anthropomorphism, but this effect is culturally mediated	M1	Yes
2. Anthropomorphism predicts lower domination and higher mutualism orientation	M2a-M2b	Yes
3. Higher mutualism and lower domination orientation are linked to a more positive attitude towards wildlife	M3	Yes

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261 **Table 2.** Mean (±SD) levels of anthropomorphism, domination, mutualism, attitudes, and idio-
262 allocentric tendencies in Spain, where participants were tested with different modalities, sepa-
263 rately for each modality (i.e., online and paper).

Modality	Anthrop.	Domin.	Mutual.	Attitudes	Idio-alloc.
Online	0.72±0.13	0.48±0.15	0.73±0.14	0.37±0.14	0.55±0.08
Paper	0.72±0.09	0.54±0.15	0.70±0.13	0.37±0.14	0.51±0.09

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265 **Table 3.** Results of the models run, including estimates, standard errors (SE), confidence intervals (CIs), likelihood ratio
266 tests (LRT), degrees of freedom (df), and p values for each test and control predictor. Control predictors are in italics. All
267 continuous test predictors and controls were *z*-transformed prior to analysis. The asterisks denote significant p values for
268 the test predictors. All models had a beta distribution.

Model	Estimate	SE	2.5% CI	97.5% CI	LRT	df	P
Model 1: Anthropomorphism							
Intercept	1.53	0.12	1.30	1.77	-	-	-
Country (Indonesia)*Modernization	0.07	0.14	-0.21	0.34	9.71	4	0.046*
Country (Malaysia)*Modernization	0.20	0.19	-0.17	0.58			
Country (Mexico)*Modernization	-0.19	0.16	-0.50	0.12			
Country (Spain)*Modernization	0.26	0.18	-0.09	0.61			
Country (Indonesia)	-0.56	0.15	-0.85	-0.27	-	-	-
Country (Malaysia)	0.25	0.17	-0.08	0.58			
Country (Mexico)	-0.12	0.16	-0.44	0.19			
Country (Spain)	-0.68	0.16	-0.98	-0.37			
Modernization	0.01	0.13	-0.24	0.26	-	-	-
Idio-allocentrism	-0.02	0.04	-0.09	0.06	0.20	1	0.655

Pet-ownership	0.10	0.04	0.03	0.18	7.50	1	0.006
Sociality	0.02	0.04	-0.06	0.10	0.19	1	0.661
Vegetarianism	0.23	0.09	0.05	0.42	6.28	1	0.012
Gender	0.01	0.08	-0.13	0.16	0.03	1	0.857
Age	-0.06	0.05	-0.15	0.04	1.40	1	0.237
Model 2a: Domination							
Intercept	-0.65	0.06	-0.77	-0.53	-	-	-
Country (Indonesia)	0.83	0.08	0.68	0.98	116.60	4	<0.001*
Country (Malaysia)	0.70	0.08	0.54	0.86			
Country (Mexico)	0.33	0.07	0.19	0.47			
Country (Spain)	0.55	0.08	0.39	0.71			
Anthropomorphism	-0.09	0.02	-0.13	-0.06	22.45	1	<0.001*
Modernization	-0.03	0.02	-0.07	0.02	1.41	1	0.234
Idio-allocentrism	0.04	0.02	0.00	0.08	3.88	1	0.049
Pet-ownership	-0.02	0.02	-0.06	0.02	1.20	1	0.274
Sociality	0.02	0.02	-0.02	0.07	1.05	1	0.306
Vegetarianism	-0.17	0.05	-0.27	-0.08	12.84	1	<0.001
Gender	0.22	0.04	0.14	0.30	30.50	1	<0.001
Age	0.03	0.02	-0.01	0.08	1.87	1	0.172
Model 2b: Mutualism							
Intercept	1.56	0.09	1.38	1.73	-	-	-
Country (Indonesia)* Anthropomorphism	-0.07	0.08	-0.22	0.08	28.99	4	<0.001*
Country (Malaysia)* Anthropomorphism	0.32	0.10	0.13	0.51			
Country (Mexico)* Anthropomorphism	0.05	0.08	-0.11	0.21			
Country (Spain)* Anthropomorphism	-0.21	0.09	-0.39	-0.04			
Country (Indonesia)	-0.53	0.11	-0.74	-0.32	-	-	-
Country (Malaysia)	-0.15	0.13	-0.41	0.11	-	-	-
Country (Mexico)	0.11	0.11	-0.11	0.32	-	-	-
Country (Spain)	-0.56	0.12	-0.79	-0.33	-	-	-
Anthropomorphism	0.35	0.06	0.24	0.46	-	-	-
Modernization	0.09	0.03	0.03	0.15	7.73	1	0.005*
Idio-allocentrism	-0.06	0.03	-0.11	-0.01	4.78	1	0.029
Pet-ownership	0.13	0.03	0.07	0.18	21.07	1	<0.001
Sociality	-0.01	0.03	-0.07	0.05	0.15	1	0.700

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Vegetarianism	0.11	0.07	-0.03	0.24	2.43	1	0.119
Gender	-0.13	0.06	-0.24	-0.03	5.78	1	0.016
Age	-0.03	0.03	-0.10	0.04	0.76	1	0.383
Model 3: Attitude							
Intercept	-0.55	0.10	-0.74	-0.36	-	-	-
Country (Indonesia)*Domination	0.03	0.10	-0.17	0.22	9.84	4	0.043*
Country (Malaysia)*Domination	-0.29	0.13	-0.53	-0.04			
Country (Mexico)*Domination	-0.14	0.12	-0.37	0.08			
Country (Spain)*Domination	-0.05	0.10	-0.26	0.15			
Country (Indonesia)*Mutualism	-0.15	0.09	-0.32	0.02	24.85	4	<0.001*
Country (Malaysia)*Mutualism	-0.47	0.11	-0.68	-0.25			
Country (Mexico)*Mutualism	-0.13	0.10	-0.34	0.07			
Country (Spain)* Mutualism	0.00	0.10	-0.18	0.19			
Country (Indonesia)	0.55	0.12	0.32	0.77	-	-	-
Country (Malaysia)	0.96	0.13	0.70	1.21	-	-	-
Country (Mexico)	0.23	0.12	0.00	0.45	-	-	-
Country (Spain)	0.05	0.12	-0.18	0.28	-	-	-
Domination	0.20	0.08	0.04	0.36	-	-	-
Mutualism	-0.02	0.07	-0.17	0.12	-	-	-
Anthropomorphism	-0.02	0.03	-0.07	0.04	0.40	1	0.527
Modernization	-0.05	0.03	-0.10	0.01	2.55	1	0.110
Idio-allocentrism	0.03	0.02	-0.02	0.08	1.51	1	0.218
Pet-ownership	-0.04	0.03	-0.09	0.01	2.18	1	0.140
Sociality	0.04	0.03	-0.01	0.10	2.15	1	0.143
Vegetarianism	-0.05	0.06	-0.17	0.07	0.65	1	0.419
Gender	0.05	0.05	-0.05	0.15	1.08	1	0.299
Age	0.10	0.03	0.03	0.16	9.12	1	0.003

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272 **Figure 1.** Mean level of participants' anthropomorphism, as a function of their country and modernity. Circles, crosses and aster-
273 isks represent participants. The dashed lines depict the model (as in model 1, but separately for each country), which has been
274 back-transformed from the log-odds ratio scale and contains standardized controls.
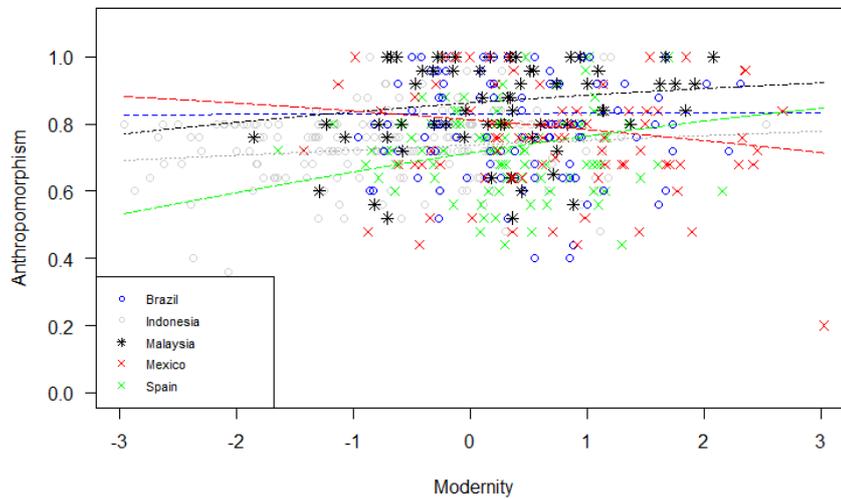
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277 **Figure 2.** Mean level of participants' mutualism orientations, as a function of their country and anthropomorphism. Circles, crosses
278 and asterisks represent participants and are jittered to avoid overlap. The dashed lines depict the model (as in model 2b, but sepa-
279 rately for each country), which has been back-transformed from the log-odds ratio scale and contains standardized controls.
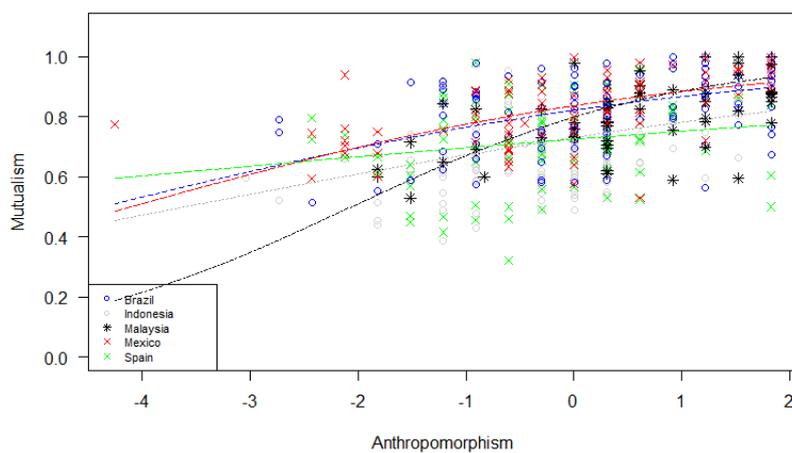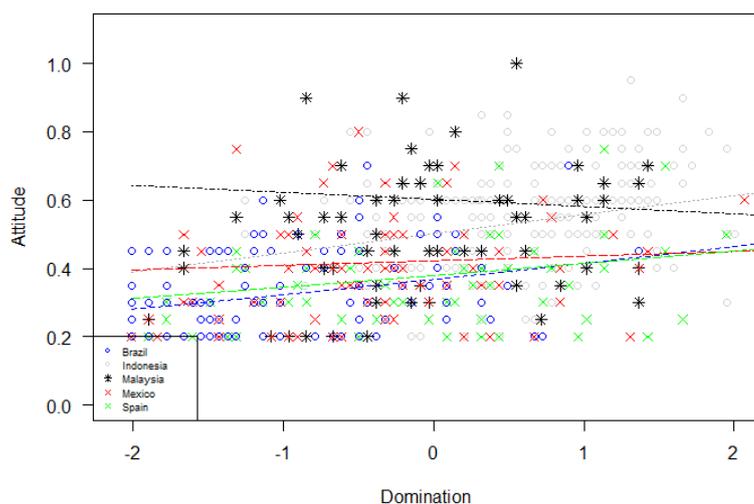

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283   **Figure 3.** Mean level of participants' attitude toward wildlife (i.e., a low score represents a better attitude), as a function of their
284   country and domination orientations. Circles, crosses and asterisks represent participants. The dashed lines depict the model (as in
285   model 3, but separately for each country), which has been back-transformed from the log-odds ratio scale and contains standard-
286   ized controls.

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289   **Figure 4.** Mean level of participants' attitude toward wildlife (i.e., a low score represents a better attitude), as a function of their
290   country and mutualism orientations. Circles, crosses and asterisks represent participants. The dashed lines depict the model (as in
291   model 3, but separately for each country), which has been back-transformed from the log-odds ratio scale and contains standard-
292   ized controls.
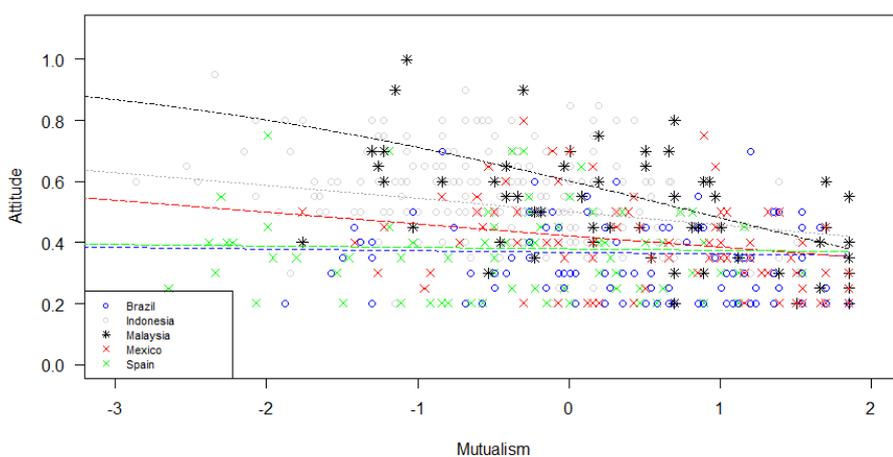
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4. Discussion

In this study, we used a cross-cultural perspective to investigate the link between modernization, anthropomorphism, value orientations (i.e., mutualism or domination) and attitudes towards wildlife. Overall, we found that the link between modernization and anthropomorphism was culturally mediated, with modernization being linked to higher anthropomorphism in some countries (i.e., Indonesia, Malaysia, Spain), but not in others (i.e., Brazil, Mexico). In turn, higher levels of anthropomorphism were linked to higher mutualism and lower domination orientations, and these to a more positive attitude towards wildlife, independently of participants' country. These results suggest that, while the link between modernization and anthropomorphism is culturally mediated, higher anthropomorphism universally predicts higher mutualism orientations and more positive attitudes towards wildlife.

In our study, higher levels of modernization (i.e., higher formal education, income, access to technologies and modern experience with animals) predicted higher anthropomorphism, but this effect was culturally mediated, in line with our first prediction (Table 1). In particular, modernization predicted higher anthropomorphism in participants from Indonesia, Malaysia and Spain, but not in Latin America, having no effect on anthropomorphism in Brazil, and predicting lower levels of anthropomorphism in Mexico. A possible explanation for this difference may be that modernization in Mexico further disrupts traditional cultural practices and beliefs. Indigenous groups living in closer contact with nature may be more likely to attribute human features to animals as a reminiscence of pre-Hispanic religious influence (i.e., nahualism, see [47]). In this case, modernization would have a negative impact on anthropomorphism, leading to the loss of traditional beliefs and ultimately decreasing anthropomorphism. Although our study cannot exactly explain which cultural aspects may be relevant for the emergence of these differences, it clearly shows that the link between modernization and anthropomorphism is culturally mediated and cannot be generalized across countries. Moreover, it suggests that general cultural differences between countries cannot alone explain the different role that modernity plays on anthropomorphism across countries (e.g., Spain and Mexico might be considered to be culturally more similar than Spain and Indonesia, yet the effect of modernization on anthropomorphism is more similar between Spain and Indonesia, than between Spain and Mexico). Therefore, future studies should aim to include more countries, and especially to better disentangle which cultural aspects exactly modulate the link between modernization and anthropomorphism, and exactly explain the differences across countries that we have evidenced here.

In line with our predictions (Table 1), anthropomorphism was linked to higher mutualism and lower domination orientations, consistently across countries. Our results showed than domination was highest in Asian countries, intermediate in Europe and lowest in Latin America. Furthermore, higher levels of anthropomorphism predicted higher mutualism in all countries, especially in Malaysia. Attributing human characteristics to non-human agents is a psychological mechanism that is deeply rooted in human behaviour, emerging early on during development and likely being universal (see [36,48,49]). Therefore, it is not surprising that anthropomorphism was consistently linked to higher mutualism and lower domination orientations across countries, despite some differences in the intensity of these interactions. Indeed, these findings are also consistent with other research in Western and non-Western countries, in which higher anthropomorphism was consistently linked to lower domination and/or higher mutualism [19,30,50,51] but (see [39]).In line with our predictions (Table 1), we also found that a more positive attitude to wildlife was predicted by lower domination and higher mutualism. Overall, our results are consistent with abundant literature showing a link between value orientations and attitudes toward wildlife (e.g., lethal removal of wolves in the USA [11]), recreational

hunting in Germany [39], hunting in the Netherlands [10]). In the future, it would be interesting to use empirical procedures to directly assess whether changes in anthropomorphism, orientations and attitude really result in behavioural changes, as human intentions do not always correspond to their practices, and positive attitudes may not necessarily result in more positive behaviours toward wildlife (see [34]).

Finally, our results showed a significant effect of several control predictors (see Table 3), largely in line with existing literature. For instance, modern attitudes towards pets and vegetarian/vegan diets were linked to higher anthropomorphism (M1), whereas pet ownhip predicted higher mutualism (M2b), as previously shown by other studies [52–55]. Being a male, having idiocentric tendencies and following no vegetarian/vegan diet predicted higher domination (M2a), whereas females, individuals with higher modernization scores and those having more allocentric tendencies also had higher mutualism (M2b), in line with literature ([56–59]; see [60,61] for a review). Finally, older participants were also more likely to have a negative attitude toward wildlife (M3), in line with previous studies showing that older people are for instance more likely to support hunting [10,61–63]. Future studies should better differentiate participants' responses depending on the target species (possibly accounting for their phylogenetic proximity to humans), and the frequency and type of previous direct experience that participants had with it, as attitudes may vary depending on the target species, and across cultures (see [30,64]).

In conclusion, our study showed that the link between modernization and anthropomorphism is not universal, but it varies across countries and is therefore likely to be culturally mediated. In some cultures, modernization might increase anthropomorphism (see Manfredo et al., 2016). In others, however, modernization might have the opposite effect, decreasing anthropomorphism and ultimately deteriorating individuals' attitude towards wildlife. Therefore, it highlights the necessity to incorporate cultural variables to the study of how modernization is linked to anthropomorphism, whereas it confirms that changes in anthropomorphism are generally associated to changes in value orientations and attitudes toward wildlife across cultures. Clearly, our study must be considered a first preliminary approach to the study of cross-cultural variation in the link between modernization and anthropomorphism. In the future, it would be essential to replicate these findings by including more countries and larger sample sizes, to also account for crucial differences across communities within the same country. Moreover, including larger sample sizes would allow researchers to explicitly assess the role that specific demographic and cultural variables (e.g., religious beliefs) play in these processes, and collect information from more representative samples. Our study, for instance, was severely limited by the fact that participants were mainly recruited among university students. Despite these limits, we believe that this study can warn us against the negative impact that modernization might have on human attitude towards wildlife, at least in some cultures, and it is an important first step into the study of cross-cultural variation in the link between modernization and anthropomorphism. Although previous research has shown a link between higher levels of modernization and higher levels of anthropomorphism, this link may not be true across all cultures, so that modernization might actually be linked to lower anthropomorphism in some cultures, with deleterious effects for conservation issues. Therefore, our results call for caution when generalizing findings across countries, and remind conservation policy makers about the importance of always taking the particular cultural context into account.

406 **Data Availability Statement:** Data will be able online after publication
411 **Conflicts of Interest:** The authors declare no conflict of interest.

412 **Appendix A**

413 *Participants.*

414

415 We recruited 741 participants across five countries (Brazil, N=156, Indonesia, N=248, Ma-
416 laysia, N=118, Mexico, N=111, Spain, N=108). Participants answering this question de-
417 scribed themselves as females (N=394) or males (N=240), with no representation of other
418 genders. Participants' age ranged from 18 to 79 (mean =28.76). Below, we report more de-
419 tailed information for each country.

423 Gender distribution by country:

	Brazil	Indonesia	Malaysia	Mexico	Spain
Female	79	146	59	60	50
Male	44	101	18	26	51
N/A	33	1	41	25	7

425 Age distribution by country*:

	Brazil	Indonesia	Malaysia	Mexico	Spain
<20	3	137	1	0	70
20-29	29	60	75	26	25
30-39	24	30	0	39	0
40-49	16	15	1	9	0
50-59	30	6	0	10	3
60-69	12	0	0	2	3
70-79	7	0	0	1	0

426 * Age has been grouped into categories in this Table for clearity, but it was used as a contintuous variable in our models.

429 Education level distribution by country:

	Brazil	Indonesia	Malaysia	Mexico	Spain
No education	0	1	0	0	0
Primary school	0	15	0	0	0
High-school	39	218	33	14	88
Bachelor	13	14	41	34	7
Postgraduate	69	0	1	38	2

N/A	35	0	43	25	11

Dietary preference distribution by country:

	Brazil	Indonesia	Malaysia	Mexico	Spain
Omnivorous	93	179	42	77	92
Vegan or vegetarian	27	63	29	8	8
N/A	36	6	47	26	8

Appendix B

Questionnaire

The questionnaire contained several questions that allowed us to build our test predictors and dependent variables. First, we assessed participants' tendency to make anthropomorphic attributions (i.e., anthropomorphism), by assigning participants a score that varied between 0 (i.e., minimum level of anthropomorphism) and 1 (i.e., maximum level of anthropomorphism). To calculate this score, we used the 5 statements by Manfredo and colleagues (18) to increase comparability, which included sentences like "Animals have free will". Participants could rate these statements on a 5-point agreement scale, from "strongly disagree" (1) to "strongly agree" (5). The anthropomorphism score was then obtained by summing all these points and dividing the sum by the maximum value that the participant could obtain (i.e., if the participant provided no answer to one of the 5 statements, the maximum value that could be obtained was 20). Second, we assessed participants' domination orientation, giving participants a score from 0 (i.e., minimum domination level) to 1 (i.e., maximum domination level). To calculate it, we scored individual responses to the 10 statements used by Manfredo and colleagues (18), including 5 domination statements like "Humans should manage fish and wildlife populations so that humans benefit" and 5 hunting statements like "People who want to hunt animals should be provided the opportunity to do so". As above, participants could rate these statements on a 5-point agreement scale. We summed the points obtained for each 5-statement group and divided the sums by the maximum value participant could obtain (as above). The mean of these two values was the participants' domination orientation. Similarly, we assessed participants' mutualism orientation, by assigning them a score from 0 (i.e., minimum mutualism level) to 1 (i.e., maximum mutualism level). As above, it was based on 5 mutualism statements like "We should strive for a world where there is an abundance of fish and wildlife for hunting and fishing" and 5 hunting statements like "Hunting is cruel and inhumane to the animals" [19]. Participants could rate these statements on a 5-point agreement scale from (as above). We summed all points for each 5-statement group, divided the sums by the maximum value participants could obtain, and used the mean of these two values as the participants' mutualism orientation.

Finally, we assessed other possible factors that might predict and/or modulate participants', anthropomorphism, domination and mutualism orientations towards wildlife. First, we assessed attitude towards wildlife, assigning individuals a score from 0 (i.e., negative attitude towards wildlife) to 1 (i.e., positive attitude towards wildlife). We calculated this score based on participants' response to 4 statements about human-wildlife conflict, like "Animals are a pest messing up the place where I live" (see Karimullah et al., in revision), to be rated on a 5-point agreement scale (as above). Participants' attitude was calculated by summing all the points obtained by each individual and dividing the sum by the maximum value that the participant could have obtained (as above).   Second, we as-

sessed participants' degree of modernization by using 8 questions and scoring the following four aspects of modernization: (i) individual income (i.e., assigning 1 to the individual declaring the highest income in each country and proportionally assigning a value to the other participants, so that income in each country varied from 0 to 1); (ii) level of formal education (i.e., with individuals who did not conclude primary school scoring 0.2, those who concluded primary school, secondary school or university 0.4, 0.6 or 0.8, respectively, and those having higher degrees scoring 1); (iii) modern experience with animals (i.e., with individuals scoring up to 1, depending on the proportion of positive answers given to 4 questions, like "Have you ever visited a zoo, a natural reserve or a similar place?"); and (iv) access to technologies (i.e., with individuals scoring up to 1 on daily use of technologies and social media, based on three questions assessing their use of social networks, hours spent watching TV and using internet). Finally, we summed the four scores (i.e., income, formal education, modern experience with animals and access to technologies), and divided the sum for the maximum score that participants could have obtained (i.e., if they provided no answer to the questions on one of the 4 aspects of modernization, the maximum score they could have obtained was 3), so that modernization could vary between 0 (i.e., minimum level of modernization) and 1 (i.e., maximum level of modernization). Third, we assessed pet-ownership dynamics (i.e., ownership and affection to pets). We assigned participants a score from 0 (i.e., minimum level) to 1 (i.e., maximum level), based on their response to 3 yes-or-no questions like "Do you own any animal?". The score was obtained by summing all the points obtained and dividing the sum for the maximum value that could be obtained (as above). Fourth, we assessed participants' sociality (i.e., frequency of social interactions) by assigning them a score between 0 (i.e., low sociality) and 9 (i.e., high sociality). We used a set of 9 open questions like "How many times do you hang out in an average week?". For each question, we then assigned 1 to the individual declaring the highest number, and proportionally assigned a value to the other participants so that these values varied from 0 to 1. For each participant, we then calculated the sociality score as the mean of her/his 9 answers. Fifth, we assessed participants' idiocentric and allocentric tendencies (i.e., idio-allocentrism index) by giving participants a number from 0 (i.e., high allocentrism) to 1 (i.e., high idiocentrism). For this purpose, we used a validated questionnaire containing 16 statements (as in [41,42]), like "I would rather depend on myself than others". Participants could rate these statements on a 5-point agreement scale (as above). Idiocentric and allocentric tendencies were then assessed by summing all the points obtained and dividing them by the maximum value that they could have obtained (as above). Finally, we collected some demographic information with open questions including participants' age, gender and dietary preferences (i.e., whether they were vegetarian or vegan).

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