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Biophobia: A Hidden Dimension of Human-Nature Relationships

# Charismatic species should be large: The role of admiration and fear

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## Abstract

1. Humans show strong preferences for large, "charismatic" animals. However, the ultimate reasons for these innate preferences remain unclear.
2. In our research, we investigate the affective components of human attitudes toward animals, as well as the willingness to pay (WTP) for their conservation in a sample of $N = 549$ Slovak people using an online questionnaire.
3. From the use of structural equation modelling, we discovered that particularly large animals trigger both biophobic (fear) and biophilic (admiration) emotions in humans, and as a result, these emotions have contrasting effects on the WTP for animal conservation. Both fear and admiration of animals were influenced by the same emotions triggered by non-animal objects. Beliefs in the magical power of animals did not directly influence the WTP animal conservation, but was mediated by the admiration of large, non-animal objects. Females showed greater WTP animal conservation than males, irrespectively of the size of the species.
4. Therefore, we believe that biophobic responses from large animals and non-animal objects in contemporary humans were inherited from our mammalian ancestors, who were targets of predation by large prehistoric reptiles throughout a significant part of mammalian evolutionary history.

**KEYWORDS**
animal conservation, biophilia, biophobia, superstition

## 1 | INTRODUCTION

The evolutionary history of *Homo sapiens* is accompanied by ancient and complex human-animal relationships motivated by affect, as well as economic self-interest (Herzog & Burghardt, 1988; Serpell, 1986, 2004). Persistent connections with animals have played a crucial role in human survival and resulted in complex interactions between biological, cultural, and psychological factors (Borgi & Cirulli, 2016; Prato-Previde et al., 2022; Serpell, 2004). With respect to the former, the deadly threat of large prehistoric reptiles favoured the evolution of the fear module in our mammalian ancestors (Öhman & Mineka, 2003) and is largely responsible for the psychology of fear of certain animals in modern humans (Öhman & Mineka, 2001; Seligman, 1971).

People's preferences of animals greatly depend on a set of physical and behavioural traits of particular species (Prokop & Randler, 2018). Human innate attraction to certain species (biophilia), as well as fear and aversion of living things (biophobia; Simaika & Samways, 2010;

Wilson, 1984) causes ambivalent and even paradoxical relationships between humans and animals (Massen et al., 2010; Prato-Previde et al., 2022). Large, phylogenetically-close, colourful animals with high cognitive capacities evoke more positive emotions and improve people's willingness to protect them compared to small and phylogenetically distant animals with lower cognitive capacities (Castillo-Huitrón et al., 2020; Lévesque et al., 2022; Lišková & Frynta, 2013; Martín-López et al., 2007; Miralles et al., 2019; Plous, 1993; Prokop et al., 2021; Prokop & Fančovičová, 2013).

Largeness is a well-documented trait associated with human positive affect, appeal, appreciation and conservation priorities (Albert et al., 2018; Berti et al., 2020; Curtin & Papworth, 2020). Rarity also affects a species' popularity (Randler et al., 2023; Żmihorski et al., 2013). For instance, people prefer large animals in zoos, despite large body sizes being more costly for maintenance rather than smaller body sizes and mammals (Frynta et al., 2010; Landová et al., 2018; Ward et al., 1998), and zoos predominantly display large-bodied vertebrates and less-threatening species to satisfy people's preferences (Balmford et al., 1995; Conde et al., 2011; Fa et al., 2014; Martin et al., 2014). People are also more prone to sponsor large-bodied mammals in zoos over other species (Fančovičová et al., 2021) and share information that favours large mammals via social networks more than about small-bodied mammals (Prokop et al., 2022).

Largeness may also elicit ambivalent emotional reactions because large animals are considered more charismatic (Albert et al., 2018; Berti et al., 2020; Clucas et al., 2008) but also more dangerous than small animals (Prokop et al., 2010, 2021; Staňková et al., 2021). Both large phytophagous mammals, as well as large carnivorous mammals, cause human mortality (Bombieri et al., 2019; Røskaft et al., 2003; Thant et al., 2022; Treves & Naughton-Treves, 1999). Human attention is significantly captured by the presence of large animals (Prokop, 2018; Ward et al., 1998; Yorzinski et al., 2014; Yorzinski & Coss, 2020). In addition, according to the stereotype content model (Fiske et al., 2002), the high intelligence (positive trait) and aggression (negative trait) of large predators are associated with mixed stereotypes of fear and admiration (Sevillano & Fiske, 2016). This evidence further supports the ambivalence of human emotional responses in the presence of large animals.

Similarly, as people admire conspecifics with high social rank (De Backer, 2012; Witkower et al., 2020) admiration works also on the interspecific level. There is a significant prevalence of beliefs about acquiring power and protection from charismatic animals, which harm people in traditional societies (Abu-Rabia, 2005; Alipoor et al., 2015; Choyke, 2010; Scrichampa, 2014; Wessing, 1995). Besides the emotion of fear, the ambivalence of human perception of animals should involve admiration, particularly in the case of large-bodied species which are potentially harmful.

Most people hold some form of superstitious beliefs that refer to an irrational and implausible causal relationship (Griffiths et al., 2019; Irwin, 1993). For instance, some university students suggest that ingestion of a boar results in receiving some of boar's properties (Nemeroff & Rozin, 2000). These associations may have a rational foundation because, for example, consumption of fatty foods may lead to obesity, and ingestion of carotenoid foods may lead to orange-pigmented skin (Foo et al., 2017; Torres & Nowson, 2007). People also believe that certain natural things, such as a tiger tooth makes you stronger and/or protects the bearer of the amulet from accidents (Abu-Rabia, 2005; Scrichampa, 2014). Superstitious beliefs enhance individuals' performance (Damisch et al., 2010) and their willingness to purchase products associated with these beliefs (Block & Kramer, 2009). Mythical beliefs also influence the human perception of animals and their behaviour toward them (Adeyanju et al., 2023; Brito et al., 2001; Ceríaco, 2012; Ceríaco et al., 2011; Fita et al., 2010; Musila et al., 2018; Onyishi et al., 2021; Prokop, Fančovičová, et al., 2009; Prokop, Özel, et al., 2009; Tarrant et al., 2016). Moreover, their occurrence may demonstrate positive or negative attitudes toward certain animals.

Attitudes, which are broadly defined as affective, cognitive and behavioural tendencies to evaluate something or someone (Eagly & Chaiken, 1993) are crucial in the shaping of human-animal relationships and the willingness to support their conservation (Castillo-Huitrón et al., 2020; Kellert, 1993,). The emotion of fear, which is an affective component of attitudes, shows a significant, negative influence on conservation attitudes (de Pinho et al., 2014; Knight, 2008; Liordos et al., 2017; Prokop & Fančovičová, 2013, 2017), as well as human willingness to pay (WTP) for conservation of particular animal species. For instance, fear played a prominent role in WTP for the conservation of bats and wolves (Johansson et al., 2012; Liordos et al., 2021), as well as in lethal control of large animals (Doney et al., 2020; Pepin-Neff & Wynter, 2018; Prokop & Fančovičová, 2010). Females are traditionally considered more empathetic, holding more positive attitudes toward animals and their welfare, but also displaying a greater fear of dangerous animals (Herzog, 2007; Polák et al., 2020; Prokop et al., 2021; Signal & Taylor, 2006; Zvaríková et al., 2021) and lower engagement in risky behaviours than males (Byrnes et al., 1999).

In this study, we investigate why animal size is a predictor of its charisma. We hypothesize that ambivalent emotional reactions are the results of mixed fear and admiration, that is both biophilic and biophobic traits. We argue that the biophobic component of largeness originates in the fear of the large, ancient predators of our mammalian ancestors, and thus modern humans inherited a fear of large, living, and non-living objects. We predict that large animal and non-animal objects receive higher scores of fear and admiration than small animals and non-animal objects. Secondly, we hypothesize that admiration, a biophilic part of human attitudes toward large animals, is associated with superstition underlain by the human affinity to acquire protection from large and powerful animals. Third, we hypothesize that superstition positively influences human WTP for their conservation. On the contrary, the emotion of fear, which is a biophobic component of human attitudes toward large animals, negatively influences the WTP. Finally, females are expected to score higher on fear of large objects and WTP for animal conservation than males.

## 2 | METHODS

### 2.1 | Participants

The study was conducted online using a Google Docs platform. We recruited 552 Slovak participants (128 males, 421 females and three with unspecified sex) aged 18–67 years ($M = 24.15$, SD = 8.06) through various social networks, university web pages and forums in order to obtain a heterogeneous sample. All participants were unpaid volunteers and blind to our research hypotheses. Written informed consent was obtained from all participants and signed prior to participation. This consent ensured the participants that the questionnaire was anonymous, and that all data would be used purely for scientific purposes. The participants were provided with the mailing address of the corresponding author in the case of any queries about their participation and data collection. Data were collected in the fall 2022. This research has been approved by the Institutional Review Board at Comenius University. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

### 2.2 | Questionnaires

#### 2.2.1 | Demographic questions

Demographic questions included age (in years) and gender (male, female or unspecified ["other"]). These three participants with unspecified gender were removed from analyses.

#### 2.2.2 | Superstitious beliefs about animals

The Paranormal belief scale (Tobacyk, 2004) traditionally used to measure superstition does not contain specific items useful for our purposes. Therefore, we self-constructed six Likert scaled items (1 = Absolutely disagree, 7 = Absolutely agree) named the Animal Power Beliefs Scale (APBS), which focused on people's beliefs regarding the transmission of animal power and protection (Table 1). The APBS showed high reliability (Cronbach $\alpha = 0.95$). Participants' scores were variable ($M = 11.43$, SD = 7.11, range 6–42). Summed scores were used for statistical analyses. High scores meant that participants had stronger superstitious beliefs about animals.

#### 2.2.3 | Visual stimuli

We prepared colourful visual stimuli of large ($N = 8$ pictures) and small ($N = 8$ pictures) non-animal objects, as well as four pictures of large animals and four pictures of small animals. All visual stimuli were downloaded from Google. Non-animal objects were always large and like their highly similar small counterparts, they included sea waves, coniferous trees, statues, hills, buildings, pyramids, bridges and flowers (large Corpse flower, *Amorphophallus titanum* and small flower of kala, *Zantedeschia claudia*). All pictures contained human(s) or at least part of the human body (e.g. hands) to provide a more reliable idea about the size of the picture. Each picture was rated on a seven-point scale regarding danger (Cronbach $\alpha = 0.80$) and admirability (Cronbach $\alpha = 0.84$; e.g. 1 = not at all, 7 = extremely dangerous).

The animal objects were large and phylogenetically similar small animal species: Polar bear (*Ursus maritimus*) and sun bear (*Helarctos malayanus*), gorilla (*Gorilla gorilla*) and Crab-eating macaque (*Macaca fascicularis*), tiger (*Panthera tigris*) and Asiatic wildcat (*Felis lybica ornata*), Northern elephant seal (*Mirounga angustirostris*), and ringed seal (*Pusa hispida*). People are able to infer animal size from pictures (Landová et al., 2018), thus all animal pictures were presented without humans. Each picture was rated on a seven-point scale regarding perceived fear (Cronbach $\alpha = 0.87$) and admirability (Cronbach $\alpha = 0.89$; e.g. 1 = not at all, 7 = extremely dangerous). The WTP for animal conservation (Cronbach $\alpha = 0.96$) was rated on the same 7-point scale (Would you be willing to financially support the conservation of this species? 1 = absolutely not, 7 = absolutely yes). Mean scores of fear, admirability and the WTP were used for statistical analyses. High scores meant that participants held a stronger fear, admirability and WTP for animal conservation.

**TABLE 1** Framework for the Animal Power Beliefs Scale.

| Statement | Source |
|---|---|
| A leopard claw necklace adds strength | Garner (1902); Nwafor (2019) |
| A tiger tooth/bone amulet gives a person fearlessness and speed | Wessing (1995); Górecka-Smolinska and Kleparski (2008) |
| Wearing an eagle feather promotes bravery in a person | Erwin et al. (1996) |
| Wearing a bear claw increases a person's strength | Choyke (2010) |
| A necklace with a shark's tooth protects a person and gives them strength | Murphy and Curran (1977) |
| A necklace with a lion's claw will protect a person | Alipoor et al. (2015) |

## 2.3 | Statistical analyses

Ratings of visual stimuli were subjected to principal components cnalysis with varimax rotation. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is an index for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients. All KMO values for data on fear and admiration of non-animal objects, fear, admiration of animals, and WTP for animal conservation were high (0.84–0.94), suggesting that the use of factor analysis was appropriate. Furthermore, we used Bartlett's Test of sphericity to examine whether the variables in the population correlation matrix are uncorrelated. The observed significance in all of the aforementioned cases was $p < 0.001$, which further allowed us to use factor analysis. We used the eigenvalue criterion of ≥1 for factor inclusion to examine whether animal size influenced ratings on fear, admiration and WTP for animal conservation.

Structural equation models (SEM) using maximum likelihood estimation were then built: one for each of the species' groups identified by factor analysis, for estimating the interrelationships among biophilic (admiration) and biophobic attitudes (fear) together with the WTP for animal conservation (endogenous variables), as well as demographic variables and superstition (exogenous variables). The overall model fit was initially assessed using chi-squared, divided by the degrees of freedom ($\chi^2$/df). We also used the comparative fit index (CFI, with an acceptable CFI ≥0.95), the root mean squared error of approximation (RMSEA, with an acceptable RMSEA <0.05) and the Tucker–Lewis index (TLI, with an acceptable TLI value ≥0.95; Kline, 2016) for fit estimation.

In the cumulative link mixed models (CLMM models), fear, admiration and WTP scores were defined as dependent variables. Size of animal (large and small), animal (yes and no) and gender of the participant were categorical predictors, whereas age and superstition score were a continuous predictor (fixed effects). The species of animal or type of object in the pictures were used as a grouping factor (random effect) to deal with correlations within the participant ratings. Models for fear and admiration were based on data for non-animal objects and animals, and the model for WTP contained only animal data. The syntax of the final CLMM models were as follows:

$$\text{Fear/Admiration} \sim \text{Gender} + \text{Age} + \text{Size} + \text{Animal} + \text{Superstition} + (1|\text{ID. object\_animal})$$

$$\text{WTP} \sim \text{Gender} + \text{Age} + \text{Size} + \text{Superstition} + (1|\text{ID. animal})$$

Descriptive statistics and factor analysis was performed with STATISTICA ver. 12.0 software. SEM and CLMM were performed with R software 4.2.2 (R Core Team, 2022) by applying "lavaan package" (for SEM; Rosseel, 2012) and the clmm function in an "ordinal package" (for CLMM; Christensen, 2022). Significance level was set at $\alpha = 0.05$.

# 3 | RESULTS

## 3.1 | Fear factor loadings

Fear scores of large and small, non-animal objects were subjected to factor analysis. All large animals loaded to PC1, thereby suggesting that participants correctly inferred their size compared to small objects. Fear of small objects loaded to three factors (PC2–PC4, Table S1).

Factor analysis on fear scores showed that all large animals except for the Northern elephant seal loaded to PC1, and all fear scores from small animals except for the sun bear loaded to PC2 (Table S2). We therefore removed the elephant seal and the sun bear from further analyses. Mean scores for small and large animals based on categorization of factor analysis are shown in Table 2.

## 3.2 | Factor loadings of admiration

Admiration scores of non-animal objects loaded to three factors. Animal scores loaded to one factor (Tables S3 and S4).

## 3.3 | Factor loadings of the WTP for animal conservation

The scores of WTP for animal conservation loaded to one factor (Table S5).

**TABLE 2** Descriptive statistics for measured traits of visual material. Large and small animals were categorized according to the results of factor analysis.

| Measured trait | Animals or non-animal objects | *M* | SD |
|---|---|---|---|
| Fear | Large animals | 5.02 | 1.56 |
| | Small animals | 2.07 | 1.11 |
| | Large non-animal objects | 2.35 | 0.96 |
| | Small non-animal objects | 1.14 | 0.27 |
| Admiration | Large animals | 5.55 | 1.31 |
| | Small animals | 4.38 | 1.47 |
| | Large non-animal objects | 4.95 | 1.00 |
| | Small non-animal objects | 2.90 | 1.13 |
| Willingness to pay | Large animals | 4.96 | 1.66 |
| | Small animals | 4.54 | 1.70 |

### 3.4 | Structural model for large animals

We analysed two sets of SEM: one with large animals (Figure 1a) and one with small animals (Figure 1b), as identified by factor analysis (Table S2), with the Northern elephant seal and sun bear excluded. The SEM fit for large animals was acceptable ($\chi^2$ p = 0.226; RMSEA = 0.026; CFI = 0.995; TLI = 0.981). The admiration of non-animal objects was positively correlated with superstition ($\beta = 0.02$, $p = 0.01$), meaning that more superstitious people tend to admire non-animal objects more. When gender is considered, our results indicate that women reported less admiration for non-animal objects as compared to men ($\beta = -0.258$, $p = 0.01$). On the other hand, the admiration of non-animal objects influenced the fear from them ($\beta = 0.171$, $p < 0.001$). Women ($\beta = 0.26$, $p = 0.006$) and young people ($\beta = -0.01$, $p = 0.048$) reported more fear toward non-animal objects, but people who admired non-animal objects also admired animals as well ($\beta = 0.622$, $p < 0.001$). There was a strong positive relationship between the fear of non-animal objects and the fear of animals ($\beta = 0.729$, $p < 0.001$) as well as between the fear and admiration of animals ($\beta = 0.197$, $p < 0.001$). Higher Fear Score for animals was given by older people ($\beta = 0.015$, $p = 0.035$). Considering the potential support for conservation, animal admiration was positively correlated with WTP for animal conservation ($\beta = 0.619$, $p < 0.001$). Subsequently, the higher animal fear score resulted in a lower score of WTP animal conservation ($\beta = -0.114$, $p = 0.005$). Women are more willing to pay for animal conservation ($\beta = 0.470$, $p = 0.001$). Overall results from SEM for large animals are presented in Table 3.

### 3.5 | Structural model for small animals

The SEM fit for small animals (Figure 1b) was also acceptable as well ($\chi^2$ $p = 0.457$; RMSEA < 0.001; CFI = 1; TLI = 1). Our results indicate that more superstitious people tend to admire non-animal objects more ($\beta = 0.043$, $p < 0.001$), as was the case of large animals. Fear of non-animal objects was positively correlated with the admiration of non-animal objects ($\beta = 0.036$, $p < 0.001$), and the admiration of non-animal objects supports the admiration of animals ($\beta = 0.638$, $p < 0.001$), where younger people tended to give a higher admiration score for animals ($\beta = -0.021$, $p = 0.002$). Fear from non-animal objects was in positive relationship with fear from animals ($\beta = 1.211$, $p < 0.001$). Unlike the case of large animals, animal admiration was not influenced by the fear of them ($\beta = 0.03$, $p = 0.328$). When gender is considered, women were afraid of animals more than men ($\beta = 0.244$, $p = 0.023$). Animal admiration increased the WTP for animal conservation ($\beta = 0.618$, $p < 0.001$), while in contrast, a higher fear score relates to a lower WTP for animal conservation score ($\beta = -0.190$, $p < 0.001$). The model indicates that women ($\beta = 0.482$, $p = 0.001$) and younger people ($\beta = -0.017$, $p = 0.022$) were more willing to pay for animal conservation. The overall results from the SEM for small animals are presented in Table 4.

### 3.6 | Cumulative link mixed models

Cumulative link mixed models for fear and admiration contain 5 fixed effects (gender, age, size of the animal, superstition, non-animal object/animal) and 1 random effect (ID object − animal species + non-animal objects; Table 5; Figure 2a). The likelihood ratio test showed that the random effect that has been included in all the CLMM models is significant ($p < 0.001$). CLMM model for fear results showed that small animals were rated with a significantly lower fear score than large animals ($\beta = -2.641$, $p < 0.001$, Table 3). Subsequently, animals were rated with a higher fear score than non-animal objects, regardless of their size ($\beta = 2.632$, $p < 0.001$). Women ($\beta = 0.093$, $p = 0.032$) and younger people ($\beta = -0.007$, $p = 0.003$) tend to be afraid of animals more than men and older people.

On the other hand, the CLMM model for admiration (Table 5; Figure 2a) showed that small animals were less admired than large animals ($\beta = -1.706$, $p < 0.001$; Table 2), while superstition is related to a higher admiration score for animals ($\beta = 0.031$, $p < 0.001$).

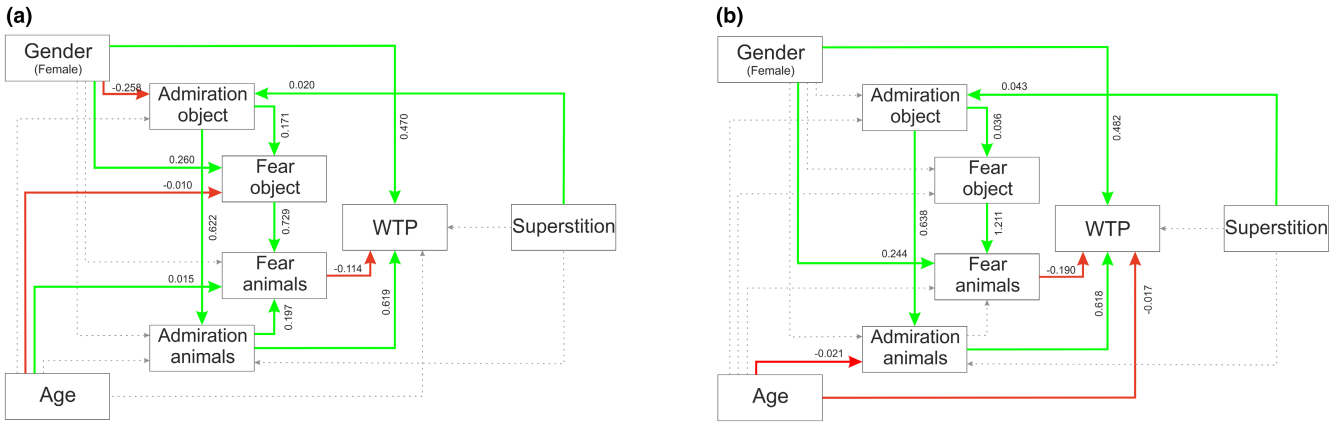


**FIGURE 1** Structural equation models for the relationships between fear, admiration, willingness to pay (WTP) for animal conservation, superstition, and demographic characteristics for large animals (a) and small animals (b). Red lines—negative relationship, green lines—positive relationship and dashed lines—non-significant relationship.

**TABLE 3** Results of the structural equation model for large animals.

| Endogenous variable | Exogenous variable | Estimate | Lower CI | Upper CI | *z*-Value | *p* |
|---|---|---|---|---|---|---|
| Fear from non-animal objects (0.049)[a] | Gender | −0.26 | −0.446 | −0.073 | −2.732 | **0.006** |
| | Age | −0.01 | −0.02 | 0 | −1.977 | **0.048** |
| | Adm_Objects | 0.171 | 0.093 | 0.25 | 4.275 | **<0.001** |
| Fear from animals (0.241)[a] | Gender | 0.259 | −0.011 | 0.528 | 1.882 | 0.06 |
| | Age | 0.015 | 0.001 | 0.029 | 2.113 | **0.035** |
| | Fear_Objects | 0.729 | 0.609 | 0.848 | 11.957 | **<0.001** |
| | Adm_Animals | 0.197 | 0.11 | 0.284 | 4.429 | **<0.001** |
| Admiration of animals (0.234)[a] | Gender | −0.185 | −0.413 | 0.043 | −1.593 | 0.111 |
| | Age | −0.003 | −0.015 | 0.009 | −0.437 | 0.662 |
| | Superstition | 0.008 | −0.005 | 0.022 | 1.18 | 0.238 |
| | Adm_Objects | 0.622 | 0.525 | 0.718 | 12.578 | **<0.001** |
| Admiration of objects (0.031)[a] | Gender | 0.258 | 0.063 | 0.454 | 2.587 | **0.010** |
| | Age | −0.002 | −0.013 | 0.008 | −0.439 | 0.66 |
| | Superstition | 0.02 | 0.009 | 0.032 | 3.428 | **0.001** |
| Willingness to pay (0.247)[a] | Gender | −0.47 | −0.756 | −0.183 | −3.213 | **0.001** |
| | Age | −0.008 | −0.023 | 0.007 | −1.099 | 0.272 |
| | Superstition | 0.002 | −0.015 | 0.019 | 0.212 | 0.832 |
| | Fear_Animals | −0.114 | −0.193 | −0.034 | −2.807 | **0.005** |
| | Adm_Animals | 0.619 | 0.524 | 0.714 | 12.754 | **<0.001** |

Significant values are in bold.
[a]$R^2$.

Animals were rated with a higher admiration score compared to non-animal objects ($\beta = 0.882$, $p < 0.001$).

The CLMM model for WTP for animal conservation indicates (Table 5; Figure 2a) that small animals ($\beta = -0.308$, $p < 0.001$) and the age ($\beta = -0.019$, $p < 0.001$) of the respondent were negatively scored toward WTP for animal conservation, and that superstition increased the WTP for animal conservation ($\beta = 0.017$, $p < 0.001$). Subsequently, women´s WTP for animal conservation was higher than men's ($\beta = 0.501$, $p < 0.001$).

The CLMM models values of logarithmic likelihood ratio AIC and marginal conditional and pseudo-$r^2$ are presented in Table 6.

## 4 | DISCUSSION

This study investigated the ultimate causes of the human perception of charismatic animals. In line with our hypotheses, we showed that human attitudes toward animals have both biophilic and biophobic components, and these components show a distinct influence on WTP for animal conservation. We also showed that the WTP for animal conservation is mediated by superstition, because superstition is associated with the biophilic component of attitudes. Our hypotheses were largely supported.

Fear and admiration have been found to be biophobic and biophilic components of human attitudes toward animals. Fear of animals was influenced by the fear of non-animal objects, and the fear of non-animal objects was influenced by their admiration. The admiration of animals influenced specifically the fear of large, but not small, animals. Large animals trigger more fear than small animals (Prokop et al., 2010, 2021, this study). Large animals (e.g. large carnivores) are generally more harmful for humans than small animals (Bombieri et al., 2019; Thant et al., 2022; Treves & Naughton-Treves, 1999), and fear of them is expected to be positively associated with their body size. Small, potentially dangerous animals, like mice, bats, or parasites, elicit fear of disease transmission or disgust (Polák et al., 2020), but their body size is not expected to correlate with human fear or with the WTP for animal conservation (Johansson et al., 2012). We hypothesize that these fears originate in ancient times when our mammalian ancestors were prey to large reptiles (Öhman & Mineka, 2003). To date, however, it has been hypothesized that an inherited fear of large reptiles is translated exclusively to fear of snakes (Öhman & Mineka, 2001, 2003), but we extend this hypothesis to a more general fear of large objects. Our mammalian ancestors coexisted with giant reptiles throughout most of the Mesozoic era. At the same time, the coexistence with Felids, mammals harmful to humans (Treves & Naughton-Treves, 1999), took only 33 million years (Gaubert & Veron, 2003). Long-lasting coexistence with reptiles influenced our minds regarding the incomparably higher prevalence of phobias from snakes, as the prototypical predators, than from Felids (Polák et al., 2020). We also suggest that a perpetual fear, which extended from animals to non-animal objects, might be adaptive even in modern society. For instance,

**TABLE 4** Results of the structural equation model for large animals.

| Endogenous variable | Exogenous variable | Estimate | Lower CI | Upper CI | *z*-Value | *p* |
|---|---|---|---|---|---|---|
| Fear from non-animal objects (0.027)[a] | Gender | 0.045 | −0.008 | 0.098 | 1.678 | 0.093 |
| | Age | 0 | −0.003 | 0.002 | −0.244 | 0.807 |
| | Adm_Objects | 0.036 | 0.016 | 0.056 | 3.567 | **<0.001** |
| Fear from animals (0.097)[a] | Gender | −0.244 | −0.454 | −0.033 | −2.27 | **0.023** |
| | Age | 0.003 | −0.008 | 0.014 | 0.614 | 0.539 |
| | Fear_Objects | 1.211 | 0.883 | 1.539 | 7.244 | **<0.001** |
| | Adm_Animals | 0.03 | −0.03 | 0.091 | 0.979 | 0.328 |
| Admiration of animals (0.263)[a] | Gender | −0.248 | −0.498 | 0.002 | −1.941 | 0.052 |
| | Age | −0.021 | −0.034 | −0.008 | −3.16 | **0.002** |
| | Superstition | 0.003 | −0.012 | 0.019 | 0.403 | 0.687 |
| | Adm_Objects | 0.638 | 0.54 | 0.735 | 12.864 | **<0.001** |
| Admiration of objects (0.077)[a] | Gender | −0.084 | −0.299 | 0.132 | −0.76 | 0.447 |
| | Age | 0.004 | −0.007 | 0.016 | 0.762 | 0.446 |
| | Superstition | 0.043 | 0.03 | 0.056 | 6.58 | **<0.001** |
| Willingness to pay (0.338)[a] | Gender | −0.482 | −0.757 | −0.207 | −3.435 | **0.001** |
| | Age | −0.017 | −0.031 | −0.002 | −2.296 | **0.022** |
| | Superstition | 0.004 | −0.013 | 0.02 | 0.453 | 0.65 |
| | Fear_Animals | −0.19 | −0.294 | −0.085 | −3.565 | **<0.001** |
| | Adm_Animals | 0.618 | 0.538 | 0.699 | 15.112 | **<0.001** |

Significant values are in bold.
[a]$R^2$.

large cars and considerable heights cause more fatal accidents than smaller ones, and in most cases, smaller cars are destroyed (Agalar et al., 1999; Evans & Frick, 1992); thus, avoidance of large objects and considerable heights motivated by fear is advantageous.

Certain other animals, like wasps or bees, are also potentially hazardous to humans (Rubenstein, 1982), and elicit fear (Bjerke & Østdahl, 2004; Polák et al., 2020). Still, mortality from stings is generally low (Gerdes et al., 2009). Therefore, these insects probably played a weaker role in human evolution than giant reptiles. Moreover, people dislike insects (e.g. Fukano & Soga, 2021; Prokop & Randler, 2018), meaning the admiration domain in the ambivalence of human emotional responses is absent here. According to this view, certain invertebrates, even though triggering fear in humans, are not natural candidates for charismatic species simply because they lack specific characteristics which humans desire to have.

The mechanism of evolved admiration of large animal and non-animal objects, based on our opinion, covary with fear; the written history of *H. sapiens* clearly shows that dominance in human hierarchical societies is historically most frequently acquired via aggression and coercion (North et al., 2009), and its high rank elicits both fear and admiration in other people (Witkower et al., 2020). Admiration can ultimately motivate humans to acquire a high rank and power they actually do not have; from this perspective, the coexistence of fear and admiration is understandable. Significantly higher scores of admiration of large animals as well as of non-animal objects, in comparison to small animals and non-animal objects, clearly support the idea that admiration is triggered by the size of the object (living or not) and this is one of the ultimate reasons why charismatic animals are of large size (Albert et al., 2018; Berti et al., 2020; Clucas et al., 2008). It must be noted that large animals were also more visible to our ancestors and food sources to them. These factors also contributed to the admiration of large animals through cultural evolution.

Superstition did not directly influence the WTP, which contradicts our hypothesis. However, the WTP for animal conservation was indirectly influenced by superstition because superstition was positively associated with admiration of non-animal objects, and admiration indirectly influenced the WTP by means of low fear and high admiration of animals. These results were strongly supported by the cumulative model for the WTP for animal conservation. The absence of direct association with the WTP for conservation could be explained by the utilitarian nature of superstition in this context (that is, acquisition of power and protection, Abu-Rabia, 2005; Scrichampa, 2014). People evidently do not associate their superstitious beliefs with the need to protect certain species, but instead value products from these animals (i.e. their body parts) with their practical and material value (Kellert, 1984). Otherwise, the influence of "positive" superstitious beliefs on attitudes toward animals is much less known than negative beliefs (e.g. Ceríaco, 2012; Onyishi et al., 2021; Tarrant et al., 2016) and require deeper attention, particularly from a cross-cultural perspective. This is because modern culture, where the research was carried out, is characteristic of high

**TABLE 5** Results of the cumulative link mixed models on the respondent's fears, admiration, and willingness to pay (WTP) ratings.

| Terms | Effect | Estimate | Lower CI | Upper CI | Odds ratio | z-Value | Variance | SD | *p*-Value |
|---|---|---|---|---|---|---|---|---|---|
| Fear | | | | | | | | | |
| Gender-female | Fixed | 0.093 | 0.008 | 0.178 | 1.097 | 2.145 | | | **0.032** |
| Age | Fixed | −0.007 | −0.012 | −0.002 | 0.993 | −2.977 | | | **0.003** |
| Size-small | Fixed | −2.641 | −2.728 | −2.553 | 0.071 | −59.331 | | | **<0.001** |
| Animal-yes | Fixed | 2.632 | 1.89 | 3.374 | 13.902 | 6.955 | | | **<0.001** |
| Superstition | Fixed | −0.002 | −0.007 | 0.003 | 0.998 | −0.866 | | | 0.387 |
| ID.object_animal | Random | | | | | | 0.379 | 0.615 | **<0.001**[a] |
| Admiration | | | | | | | | | |
| Gender-female | Fixed | −0.025 | −0.096 | 0.047 | 0.975 | −0.682 | | | 0.495 |
| Age | Fixed | −0.002 | −0.006 | 0.002 | 0.998 | −1.046 | | | 0.296 |
| Size-small | Fixed | −1.706 | −1.772 | −1.64 | 0.182 | −50.739 | | | **<0.001** |
| Animal-yes | Fixed | 0.882 | 0.218 | 1.546 | 2.416 | 2.605 | | | **0.009** |
| Superstition | Fixed | 0.031 | 0.027 | 0.036 | 1.031 | 13.951 | | | **<0.001** |
| ID.object_animal | Random | | | | | | 0.302 | 0.55 | **<0.001**[a] |
| WTP | | | | | | | | | |
| Gender-female | Fixed | 0.501 | 0.374 | 0.627 | 1.65 | 7.778 | | | **<0.001** |
| Age | Fixed | −0.019 | −0.025 | −0.012 | 0.981 | −5.418 | | | **<0.001** |
| Size-small | Fixed | −0.308 | −0.413 | −0.203 | 0.735 | −5.765 | | | **<0.001** |
| Superstition | Fixed | 0.017 | 0.01 | 0.024 | 1.017 | 4.533 | | | **<0.001** |
| ID.animal | Random | | | | | | 0.005 | 0.073 | 0.07[a] |

Significant values are in bold.

[a]Likelihood ratio tests of cumulative link models.

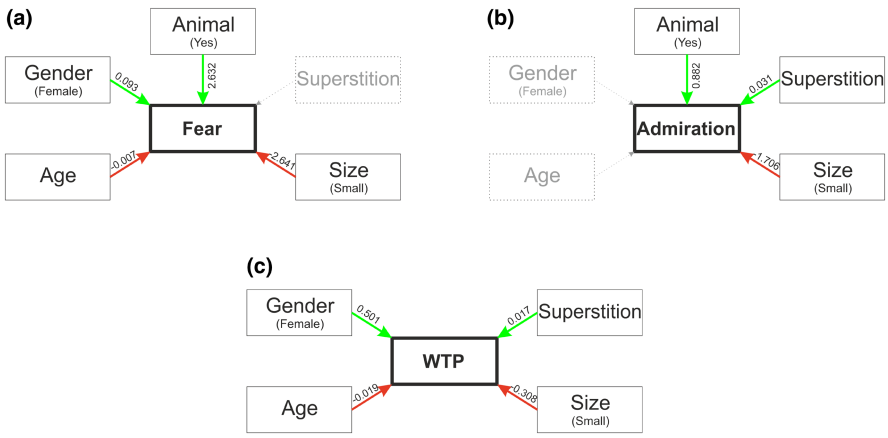


**FIGURE 2** Cumulative link mixed models for fear (a), admiration (b), and willingness to pay (WTP) for animal conservation (c). Red lines—negative relationship, green lines—positive relationship and dashed lines—non-significant relationship.

urbanization and reduced interactions between people and nature (Fukano & Soga, 2021; Soga et al., 2016, 2020), where beliefs in the magical power of animals needn't be necessarily compromised.

The WTP for animal conservation was negatively influenced by biophobic (fear) and positively by biophilic (admiration) components of attitudes toward animals and gender, which therefore supports our hypothesis. Fear showed a negative influence on WTP for animal conservation. Fear triggers avoidant behaviours and concerns from physical harm; thus, greater fear interferes with conservation needs (Castillo-Huitrón et al., 2020; Prokop & Fančovičová, 2013; Weinstein et al., 2015) and participating in actions aimed at eliminating wildlife (Soga et al., 2023). For example, when participants rated pictures of large or aggressively-looking animals, their willingness to protect them was lower than for smaller animal species, even when the same animals were presented in neutral postures (Prokop et al., 2021; Prokop & Fančovičová, 2017). On the contrary, the admiration of animals strongly influenced WTP animal conservation, regardless of the size of the animal species. Similarly, traits that

**TABLE 6** Log Likelihood-ratio, Akaike information criterion, marginal and conditional $r^2$ values of cumulative link mixed models.

| Value/model | Fear | Admiration | Willingness to pay |
|---|---|---|---|
| Log likelihood ratio | −15,584.02 | −23,319.44 | −8051.89 |
| Akaike information criterion | 31,192.05 | 46,662.87 | 16,125.77 |
| Conditional $R^2$ | 0.527 | 0.276 | 0.034 |
| Marginal $R^2$ | 0.473 | 0.209 | 0.032 |

increase the admirability of trees (e.g. rarity) increased public WTP for trees in China (Chen, 2015). The statistical impact of admiration on the conservation of WTP for animal conservation in the present study was stronger than fear; therefore, conservation campaigns should consider the physical and psychological traits that underlie the admiration of focal species to increase the public willingness to protect them. Our results further contribute to the role of biophobic and biophilic components in the WTP for animal conservation (Johansson et al., 2012; Liordos et al., 2021).

The strong impact of animal admiration on WTP for animal conservation can be utilized in rewilding, which also promotes wildlife comeback (Navarro & Pereira, 2015). The return of megafauna, including both herbivores and predators, will lead to a rapid recovery of the functioning of natural ecosystems, especially in disturbed European habitats (Ritchie & Johnson, 2009; Sekercioglu, 2006). The use of human admiration of large animals in nature conservation campaigns can reduce their negative attitudes toward predators mediated by fear (Johansson et al., 2012; Kaczensky et al., 2004; Prokop & Fančovičová, 2010). Supportive attitudes and WTP for animal conservation will lead not only to an increase in the megafauna population but also to the restoration of natural vegetation (Ceauşu, Carver, et al., 2015) and an overall increase in species richness (Ceauşu, Hofmann, et al., 2015). Given that animal admiration showed a stronger impact on WTP for animal conservation in our study, we believe that the innate fear of megafauna can be overcome by communication and the promotion of values that humans admire in these animals.

Corresponding to our hypothesis, females showed greater WTP animal conservation, regardless of species size, probably as a result of their greater empathy and positive attitudes toward animal welfare (e.g. Herzog, 2007; Signal & Taylor, 2006). However, females unexpectedly showed a greater fear of small animals, whereas a fear of large animals was not influenced by gender differences. This result is surprising, given that females generally show a preference for cute, small animals, while males show a greater preference for unpopular and feared animals (Borgi & Cirulli, 2016; Lindemann-Matthies, 2005; Prokop & Tunnicliffe, 2010; Prokop et al., 2021). On the other hand, females showed a greater fear and lower admiration of large non-animal objects, further supporting their greater risk aversion compared with males (Byrnes et al., 1999). Overall, these results suggest that biophobic and biophilic affective traits are triggered by adult females, particularly for non-animal visual cues rather than for animal visual cues, and their influence on animal fears is indirect.

We did not establish specific hypotheses for the effect of age on the WTP for animal conservation, because these influences are usually weak or absent (Jaunky et al., 2021; Johansson et al., 2012; Liordos et al., 2021; Vincenot et al., 2015). In our study, older people showed a lower fear and lower WTP for animal conservation. Younger people showed a greater fear and WTP for animals than older people. These results support the idea that younger people have a greater interest in nature conservation (Knight, 2008; Liordos et al., 2017), which needs to be considered in planned conservation activities.

## 4.1 | Limitations

Our data were obtained through a cross-sectional design; therefore, it is implausible to determine causality among the variables. Moreover, attitudes toward animals are partly shaped by cultural differences (Serpell, 2004) but our research is based on data from within a single country. We also acknowledge that WTP for animal conservation might vary between cultures because, for instance, humans value native animals differently than non-native animals (Lipták et al., 2023), and superstition shows greater prevalence in non-western countries (Toth, 2019). However, suppose our hypothesis about the fear of large animals derived from the fear of prehistoric reptiles is correct. In that case, we predict that associations between fear and admiration of large animals should be stable across cultures, given that fear of snakes is universal (Öhman & Mineka, 2001). Therefore, additional cross-cultural research is required before firm conclusions can be made.

In conclusion, our research showed that both biophobia and biophilia affect attitudes toward animals. Simultaneous activation of these two affective traits is adaptive in terms of protection against physical harm (fear) and motives to acquire a fearful object (admiration), ultimately enhancing our own social status. These mechanisms are good candidates for explaining the human fascination of large objects and finally, why we consider large animals more charismatic than small species. Our hypothesis of a generalized fear of ancestral reptiles and large animals, as well as non-animal objects, clearly requires further examination. A better understanding of the factors underlying biophobic and biophilic affective responses is crucial for improving evolved interactions between humans and nature.

## AUTHOR CONTRIBUTIONS

Pavol Prokop conceived the original idea for the research, which was further elaborated by Martina Zvaríková, Zuzana Ježová and Peter Fedor. Data was collected by Pavol Prokop, Martina Zvaríková, Zuzana Ježová and Peter Fedor; Milan Zvarík analysed the data. Pavol Prokop, Martina Zvaríková and Milan Zvarík wrote the manuscript, which was reviewed and edited by all authors. All authors gave final approval for publication.

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## CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest.

## DATA AVAILABILITY STATEMENT

The data used for this study are available at: https://doi.org/10.5061/dryad.bnzs7h4gd.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**Table S1.** Factor analysis on perceived fear of non-animal objects.

**Table S2.** Factor analysis on perceived fear of animals.

**Table S3.** Factor analysis on the admiration of non-animal objects.

**Table S4.** Factor analysis on the admiration of animal objects.

**Table S5.** Factor analysis on willingness to pay animal conservation.

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