Understanding human attitudes towards bats and the role of information and aesthetics to boost a positive response as a conservation tool

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Abstract

An understanding of human attitudes towards wildlife can be an essential element in the success or failure of a conservation initiative, policy or practice and represents one of the main conservation problems for wildlife species. Despite the ecosystem services bats provide, they often are a socially stigmatized group, misperceived and even hunted. This problem has been on the increase as a result of the Covid-19 pandemic. We examined how aesthetic appeal and informational factors could influence human attitudes towards bats in a survey of 1966 participants from Spanish-speaking countries. Gender, educational level, religiousness and previous experiences with bats were relevant variables to understand attitudes towards them. The results indicate that both aesthetic and informational stimuli increase the positive responses, reducing the negatives on the participants' attitudes. Our results show the importance of public attitudes to achieve conservation goals, especially in the context of human-wildlife conflict. Bats are not charismatic animals and are still surrounded in mystery; however, our findings could benefit bat conservation plans, allowing the development of new communication strategies both locally and nationally and increasing public acceptance that will facilitate bat conservation.

Introduction

Bats are the second most diverse mammal group. With >1400 species (Upham et al. 2019), they occupy a great variety of trophic niches, fulfilling numerous functions in maintaining the ecosystems' health (Jones et al. 2009) and providing relevant ecosystem services for humans as seed dispersers, pollinators and pest suppressors with substantial impact for the socioeconomic systems (Boyles et al. 2011; Kunz et al. 2011). However, various studies show that social perception of bats tends to be negative (e.g., Bhattacharjee et al. 2018; Kingston 2016; Prokop et al. 2009; Reid 2016; Sexton & Stewart 2007). This perception worsened due to the Covid-19 pandemic, in which bats have been implicated as a possible origin (Zhao 2020; Zhou et al. 2020), although people misunderstood the relationships between them (Covid-19 and bats) even with a sample of 15 000 Chinese

participants (Lu et al. 2021). At global level, bats suffer a scarce persecution even though a few misguided actions have the potential to cause irrevocable damage to an already vulnerable species (Kross et al. 2018; Lim & Wilson 2019; Moran et al. 2015; Ohemeng et al. 2017; Reid 2016; Shapiro et al. 2020), especially when people receive misinformation and misleading negative associations (MacFarlane & Rocha 2020). Therefore, it is essential to contribute with information that helps to understand how people perceive bats and to identify the most persuasive communication strategies to produce an attitudinal change for their conservation.

Social research on public attitudes to bats has grown in recent years, but it remains in the early stages (Kingston 2016; Knight 2008; Musila et al. 2018; Prokop et al. 2009). Based on the studies by Kellert (1984), several works have constructed a *Bat Attitude Questionnaire* to explore the attitudes towards bats in five dimensions:

Myths, Negativistic, Scientist, Ecologistic and Knowledge (Musila et al. 2018; Prokop et al. 2009; Prokop & Tunnicliffe 2008). These dimensions can be related to aesthetic characteristics (physical attractiveness) and potentially modify the social perception of bats (Kingston 2016; Knight 2008), since aesthetics, or affective attributes, favour more interest and attention towards animals. Beautiful and attractive animals causing "positive" emotions (e.g., happiness and surprise) receive special attention driving in situ and ex situ conservation actions (Castillo-Huitrón et al. 2020; Gunnthorsdottir 2001; Miralles et al. 2019). However, the physical appearance varies widely among bat species on a global scale, making difficult at times to interpret the social perceptions. Other factors such as knowledge, gender, educational levels and myths could affect the perceptions that people have of bats. Unfortunately, some of these studies have a limited sample, hindering effective collection of general results.

Human activities are the main threat for bats (Frick et al. 2020), and understanding the motivations and social perception of humans towards bats is a powerful tool to develop conservation and management plans for these mammals. Indeed, these assessments of the perceptions are crucial; thus, appropriate awareness programmes can be devised, and negative social attitudes (if any) rectified (Castillo-Huitrón et al. 2020).

Bat conservation goals cannot be pursued in isolation from social sciences, and it is necessary to identify human attitudes relevance for emerging conservation strategies, particularly with no-charismatic species. We hypothesized that small stimuli could improve the human attitudes towards bats. Therefore, we surveyed if information and aesthetic appeal influences these attitudes across the Spanish-speaking countries (which harbour a high bat species biodiversity). Our specific objectives were (1) to understand the influence of socio-demographic variables in the public's attitudes towards bats, (2) to assess the effects of stimuli in human attitudes and (3) to identify possible barriers to improve the communication strategies for conservation.

Materials and methods

Field survey

We surveyed 1966 participants from 17 Spanish-speaking countries (Table in Appendix S1). We used non-probability sampling by convenience through the application of an online questionnaire. Inclusion criteria were to be over 18 years old and not being professionally or productively related with agricultural activities, who were evaluated in a separate study due to the direct implications of bats in their activities. Participants ranged between 18 and 84 years old (Mean $\pm$ SD = 29.8 $\pm$ 12.0; socio-demographic characteristics of the sample available in Table in Appendix S1).

During April 2019, we tested a preliminary version of the questionnaire with 80 participants to adapt the questions and languages carefully. The final version of the questionnaire was implemented between August and November of 2019,

which was distributed via e-mail (universities, governmental offices, associations and ONGs) and different digital channels and virtual platforms (e.g., Facebook, Twitter and Instagram) in Spanish-speaking countries. Thus, we invited the participants to collaborate in this study and to share the questionnaire through their social media accounts. This process is random and guarantees the representativeness and equity of the sample. When entering the questionnaire, they had access to a text which detailed information such as the project name and the aims of the study. Information was also provided on the names and e-mails of the responsible researchers as well as their respective institutions. Additionally, the initial text detailed the ethical safeguards included to ensure the integrity, anonymity and well-being of those wishing to participate. At the end of the text, the participants had to answer the question 'Do you wish to participate in the study?' with the options 'yes' or 'no'. Only by marking the option *yes* did they gain access to the questionnaire which took ~20 min to complete. They were able to leave the questionnaire at any time.

Questionnaire design

The first section of the questionnaire included socio-demographic information (Appendix S1). After that, participants were randomly assigned to one of four experimental conditions, in which the information provided or the visual stimulus on bats varied (see Appendix S2). Options for the visual stimuli included (A) a picture of a panda bat (*Niumbaha superba*) without any other information; (B) a picture of a vampire bat (*Desmodus rotundus*) without any other information; (C) a 72-s video with animated bat cartoons and information mentioning their benefits on pest suppression in agriculture contexts and (D) a control group that did not receive any information or visual stimulus.

In the second section, we asked participants about their interaction with bats. This section included questions such as 'Have you ever seen a bat in real life (not just through pictures or videos)?' (1 = *yes*; 2 = *no*). This allowed us to assess if the participants had any previous experiences with bats.

In the third section, in order to measure the participants' attitudes towards bats, we used the Bats Attitudes Standard Scale (BAtSS). Design, psychometric properties of BAtSS and the questionnaire are available at Pérez et al. (2021). This scale consists of 34 items with a Likert-type response ranging from 1 (*totally disagree*) to 5 (*totally agree*). These items are divided into four dimensions: *Scientistic* (seven items; $\alpha = 0.914$); *Positivistic* (nine items; $\alpha = 0.898$); *Myths* (four items; $\alpha = 0.750$) and *Negativistic*, which in turn consist of three sub-dimensions: *Negativistic-Emotional* (three items; $\alpha = 0.755$); *Negativistic-Behavioural* (four items; $\alpha = 0.890$) and *Negativistic-Cognitive* (seven items; $\alpha = 0.863$). The *Scientistic* and *Positivistic* dimensions are considered positive attitudes and a high score in them means a positive response. However, the *Myths* and *Negativistic* are negative attitudes and a high score in them means a negative response.

Statistical analyses

At first, we checked for a normal distribution of data. Although none of the variables fulfilled the assumption of normality, several studies have reported that the family of *t* and *F* parametric tests are robust in the non-fulfilment of this assumption with reasonably large samples (Blanca et al. 2017; Rasch & Guiard 2004). However, to ensure the reliability of the results, non-parametric tests were performed complementarily to corroborate the findings. When there was a coincidence between parametric and non-parametric tests, the parametric results were reported to improve the statistical power.

We used *F* tests to make comparisons among socio-demographic variables; ANOVA with Turkey's post hoc test when homogeneity of variances assumption was met and Welch with Games-Howell post hoc when it was not. Holm-adjusted *p* was considered to avoid type I error increasing due to post hoc multiple comparisons. *F*-test effect size was calculated through partial omega squared (ω_p^2). These analyses were performed with the R package *ggstatsplot* (Indrajeet Patil et al. 2020).

To evaluate attitudes towards bats in people receiving one of the four different stimuli, one-way MANOVA was used to reduce the inflation of the type I error. Additionally, we used a hierarchical weighted least squares (WLS) regression model to weight the effect of different stimuli on the participants' attitudes, controlling for socio-demographic variables. Before performing the analysis, we removed univariate outliers (SD ± 3.0) and multivariate outliers (Cook's and Mahalanobis distance). We checked for linearity, homogeneity of variances, independence of error, normal distribution of the residuals, and multicollinearity to ensure the model validity. The only unfulfilled assumption was the homogeneity of variance; however, a WLS hierarchical regression model is robust in the non-fulfilment of this assumption. We calculated the effect size for the regression models using Cohen's f^2. These analyses were performed with SPSS v. 25.

Results

Attitudes towards bats

We found significant differences in all attitude dimensions by gender, where males had a positive attitude towards bats (high score in the *Positivistic* and *Scientistic* dimensions), while females showed a significant negative attitude (high score in *Negativistic* and *Myths* dimensions; Table 1; Appendix S3A). For the educational level, again, there were differences in all the dimensions, where high educational levels had positive influence towards bats with higher scores in the positive attitudes and lower in the negatives (Table 1 and Appendix S3B).

Previous experiences with bats had a significant effect on people attitudes towards bats. Those individuals who responded *yes* to the questions 'Have you ever seen a bat?' had a higher score in the positive dimensions and a lower score in the negatives (Table 1; Appendix S3C). Also, the religiousness was a significant variable. Results showed that Christian people had a lower score in the positive dimensions and higher score in the negatives with respect to participants practicing other religions or having any beliefs at all (Table 1; Appendix S3D).

Aesthetics and information effects on the attitudes towards bats

People's attitudes towards bats did not show differences among the received stimuli with respect to age, gender,

Table 1 Differences among human attitudes towards bats in Spanish-speaking countries regarding socio-demographic factors

Factor	Human attitudes towards bats					
	Scientistic	**Positivistic**	**Myths**	**Neg. Emotional**	**Neg. Behavioural**	**Neg. Cognitive**
Gender Male - Female ♂ ♀	♂ > ♀	♂ > ♀	♂ < ♀	♂ < ♀	♂ < ♀	♂ < ♀
Religiousness Other-Christian-None	✡ > ✝ < ✗	✡ > ✝ < ✗	✡ = ✝ < ✗	✡ < ✝ > ✗	✡ = ✝ > ✗	✡ < ✝ > ✗
Have you ever seen a bat? Yes - No	👁 > 🚫	👁 > 🚫	👁 < 🚫	👁 < 🚫	👁 < 🚫	👁 < 🚫
Educational level Undergraduate - University - Postgraduate	🎓 = 🎓 > 💼	🎓 < 🎓 < 💼	🎓 = 🎓 > 💼	🎓 = 🎓 > 💼	🎓 = 🎓 > 💼	🎓 > 🎓 > 💼

Factor's symbols indicate the mean score obtained in the Likert's scale from 1 (*totally disagree*) to 5 (*totally agree*). The mathematical symbols (=; <; >) indicate the relation between the factors. This table only shows where there were significant differences. Full model results in Figures in Appendices S1–S5.
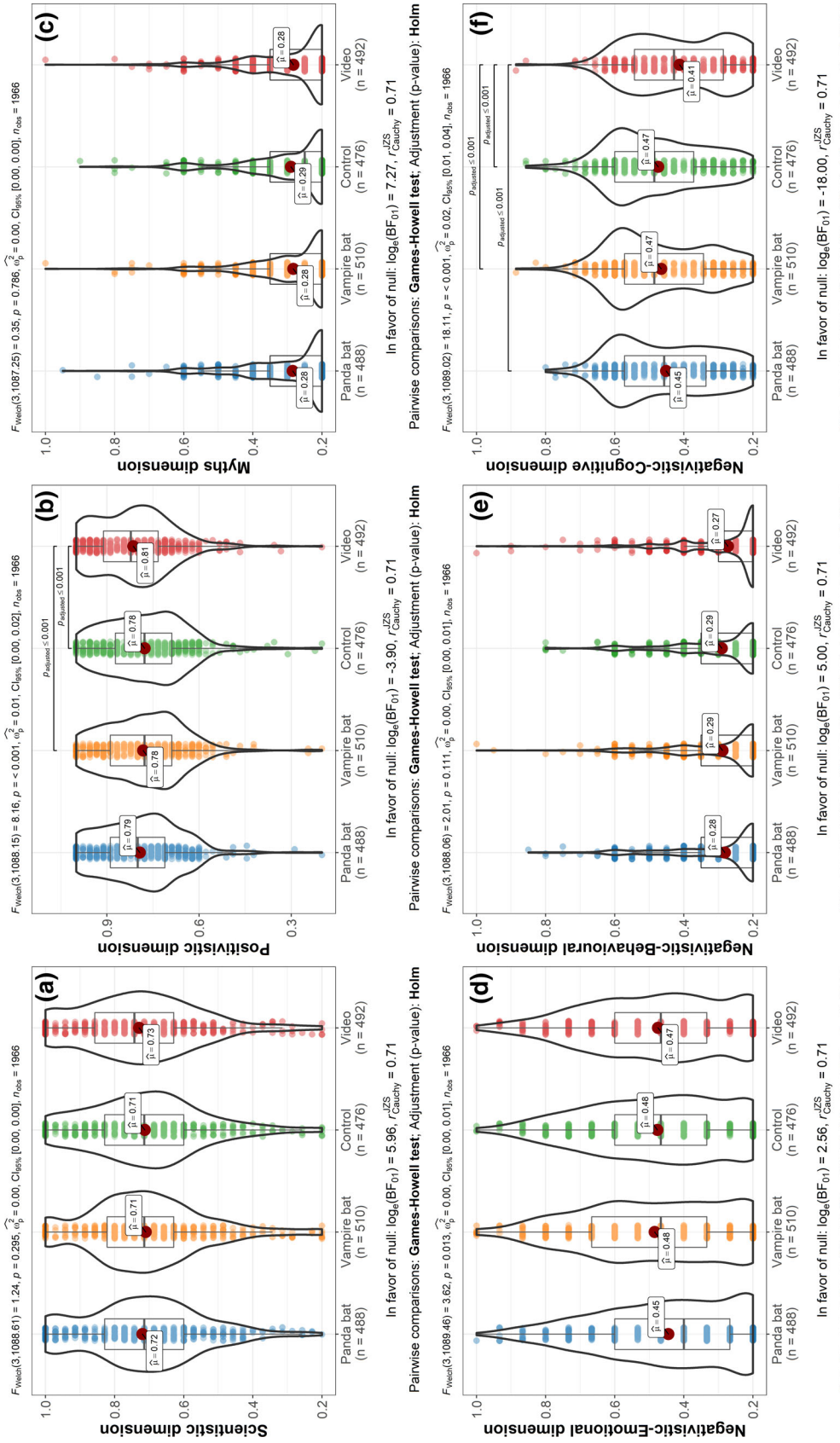
Figure 1 Relation between experimental condition and human attitudes towards bats in a questionnaire applied in 17 Spanish-speaking countries. All the statistical data are available in the figure [Colour figure can be viewed at zslpublications.onlinelibrary.wiley.com.]

Table 2 Hierarchical weighted least squares regression model for BAtSS dimensions

	Positivistic				Negativistic-Emotional			
	Model 1		Model 2		Model 1		Model 2	
Variables	B (SD)	β	B (SD)	β	B (SD)	β	B (SD)	β
Constant	35.225 (0.605)	–	34.947 (0.604)	–	5.776 (0.383)	–	5.961 (0.384)	–
Sex (Female)[a]	−1.643 (0.235)	−0.151***	−1.612 (0.234)	−0.148***	0.744 (0.131)	0.123***	0.731 (0.130)	0.121***
University[b]	1.037 (0.273)	0.086***	1.053 (0.272)	0.087***	−0.156 (0.147)	−0.024	−0.129 (0.147)	−0.020
Post-graduate[b]	2.116 (0.318)	0.152***	2.145 (0.317)	0.154***	−0.343 (0.168)	−0.042*	−0.336 (0.186)	−0.041*
Religiousness (Believers)[c]	−1.680 (0.234)	−0.154***	−1.712 (0.233)	−0.157***	1.378 (0.131)	0.227***	1.384 (0.131)	0.227***
Have you seen a bat? (Yes)[d]	1.793 (0.258)	0.153***	1.743 (0.256)	0.149***	−1.021 (0.148)	−0.151***	−1.046 (0.148)	−0.155***
Video[e]			1.251 (0.265)	0.100***				
Panda bat[e]							−0.547 (0.147)	−0.080***

[a] Male; [b]Undergraduate; [c]Non-religion; [d]No; [e]Control group; *<0.05 statistical significance; **<0.01 statistical significance; ***<0.001 statistical significance

educational level or religiousness. We did not find differences for *Scientistic* dimension (Fig. 1a), but there were significant differences for *Positivistic* dimension where the post hoc test revealed that the people who saw the 'video' had a higher score than those who saw the 'vampire bat' or the control group (Fig. 1b). Also, our results did not find significant differences in any experimental condition for *Myths* or *Negativist-Behavioural* dimensions (Fig. 1c,d).

However, we found significant differences for *Negativist-Cognitive* and *Negativist-Emotional* dimensions between the received stimuli. Our results show that the people who saw the 'video' had lower score for the *Negativist-Cognitive* dimension (Fig. 1e), reducing their negative attitude. Although there are significant differences for *Negativist-Emotional* dimension, the post hoc test could not reveal differences between groups.

People's attitudes towards bats were affected by several aspects of their sociocultural context. WLS regression model was constructed for the *Positivistic* and *Negativistic-Emotional* dimensions (Table 2). The *Positivistic* dimension increased in those who had reached university and post-graduate studies. Also, a positive and significant effect was observed in those who had seen a bat in real life. Conversely, a negative effect was observed in gender (female) and religiousness. The second model to predict the positivistic attitudes show that the 'video' experimental condition was significant (Table 2). For the *Negativist-Emotional* dimension, the model showed that the same variables (female, graduate student, religion and having seen a bat) have a negative effect in this dimension in addition to the 'panda bat' stimulus having a negative effect in the model (Table 2).

Discussion

Addressing the human-bat conflict requires an understanding of how the public perceives and responds to bats (Castillo-Huitrón et al. 2020; Lim & Wilson 2019). Considering the public attitudes towards bats is the keystone to develop conservation and management plans, especially linking the

influence of information and aesthetic in the change of human attitudes to get the conservation goals (Castillo-Huitrón et al. 2020; Miralles et al. 2019). Historically, bats have been associated with a wide variety of myths and beliefs (e.g., Castilla et al. 2020; Kamins et al. 2015; Kross et al. 2018; Lim & Wilson 2019; Shapiro et al. 2020; Suwannarong et al. 2020), most of them related to bats being hunted or killed. Now, due to the Covid-19 pandemic, addressing this issue represents an urgent challenge (Lu et al. 2021; Sasse & Gramza 2020) since the misinformation in social media has increased these negative associations. Therefore, it is necessary to develop tools to enhance the bat biodiversity which is essential for the ecosystems (Lu et al. 2021; MacFarlane & Rocha 2020). Aside of information, other studies showed that the human perceptions of bats are associated with aesthetical appearance because most people think they look creepy or ugly (Kingston 2016).

This study examined the impacts of new information and the aesthetic appeal on and individual's attitudes towards bats in Spanish-speaking countries, where we find a vast bat diversity of several trophic niches (Castillo-Huitrón et al. 2020; Upham et al. 2019). We observed that gender, educational level, religiousness and previous contact with bats were associated with attitudinal dimensions. Regarding gender, females tended to have a more negative attitude than males (Bhattacharjee et al. 2018; Lu et al. 2021; Musila et al. 2018; Prokop & Tunnicliffe 2008; Shapiro et al. 2020; Suwannarong et al. 2020), probably because bats are often associated with fear-relevant animals, such as rats and mice (Polák et al. 2020). This is an important factor to be considered in conservation strategies or campaigns, where the information approach should differ according to gender. Some authors related these differences with the gender role in the society (Castillo-Huitrón et al. 2020).

On the other hand, the educational level can reduce these negative attitudes (Castilla et al. 2020; Reid 2016) as well as previous visual contact with bats. Therefore, the inclusion in environmental education programmes of activities such as visual contact with bats could help promote positive attitudes towards them. Regarding religiousness, Christian religion

especially has a negative effect on attitudes (Castillo-Huitrón et al. 2020; Mahmood-ul-Hassan et al. 2011; Ohemeng et al. 2017), probably because of bat wings being associated with the devil in catholic religious representations since medieval periods (Valentini & Ristorto 2015) and people preferring culturally important and historically familiar animals (Gunnthorsdottir 2001).

Our results highlight that the aesthetic and information provision can play a role in public attitudes towards bats and could generate a positive reaction to these animals. Notably, informing people on bat benefits for agriculture through a short video increased the positive perception towards bats significantly, reducing the *Negativistic-Cognitive* dimension. This information did not influence the remaining participants' attitudinal dimensions. The 'panda bat' stimulus, as an example of species with an attractive aesthetic, decreased the *Negativistic-Emotional* perception significantly, although with a smaller effect. However, the 'vampire bat' image (unsightly) did not generate significant changes. The hierarchical regression models confirmed that the informative video contributed significantly and independently to the increase in positive attitudes, controlled by socio-demographic variables. When people had information and perceived the benefits provided by bats, they were sufficiently powerful elements to create persuasive messages and to change attitudes (Castilla et al. 2020; Guenther & Shanahan 2020; Lim & Wilson 2019). In a recent study, Straka et al. (2020) found that photographs of vulnerable and distressed bats might be an important tool to temporarily increase people's emotional reactions to bats, their wildlife value orientation and probably, more importantly, their support for bat conservation. These findings illustrate the relevance of information to promote animal conservation and highlight the relevance of developing effective communication campaigns based on scientific findings (Cusack et al. 2021; Lu et al. 2021; MacFarlane & Rocha 2020).

Developing wide-scale surveys in different countries could be a crucial task to improve people's engagement in conservation campaigns for bats protection (Gunnthorsdottir 2001; Kingston 2016). Our results show that it is possible to modify people's attitudes towards bats and to act against their threats through visual and informational stimuli, which reinforce the importance of well-developed communication campaigns (MacFarlane & Rocha 2020). However, it is important to point out that attitudes and behaviour are not always directly correlated. The relationship between these two concepts is complex, and multiple variables must be taken into account to fully understand it (e.g., behavioural control beliefs, cognitive processing and situational factors; Frymier & Nadler 2017; Shrigley 1990). Thus, our study identifies different strategies to change attitudes, but they cannot guarantee behavioural changes. For this purpose, further studies are needed. On the other hand, in our study, neither aesthetic appeal nor information generated significant changes in myths, scientific and positivistic attitudinal dimensions. These results should not be surprising since the stimuli in our experiment were too simple to modify such deeply rooted attitudes that have been probably consolidated in the long term. Future research should address the extent to which more sophisticated stimuli could achieve more relevant and stable changes, leading human behaviour towards bat conservation.

To further increase the acceptance of bat biodiversity, three drivers seem to be shaping people's attitudes and should receive more considerable attention from wildlife conservation and planning: first, the significance of knowledge about bat biodiversity and their benefits for humans, especially highlighting their role in local and national economies as pest suppressors or pollinators. Indeed, their role in the prevention of zoonosis (malaria, dengue, etc.) associated with vectors such as mosquitoes (Puig-Montserrat et al., 2020). The second one is the importance of having a previous experience with bats. In this way, conservationists should plan outreach activities, where people can get some experience with bats such as listening to ultrasounds or watching them work, obviously always considering all the safety measures needed to make the activity and following the guidelines of Bat Conservation International. This can be an important inter-generational strategy to avoid negative attitudes towards fearsome and disgusting animals and promote positive emotions (Castillo-Huitrón et al. 2020). In these cases, participation of wildlife management agencies is crucial given their social confidence. The third is to take in mind socio-demographic variables and religiousness of the people to achieve an effective conservation campaign, for example, designing specific campaigns for different religious groups (with the consent of their spiritual leader) to break up with myths and avoid misleading behaviour (Treves & Santiago-Ávila, 2020). Beyond mythology, other elements that have facilitated the development of cultures (e.g., art, literature, symbolism and religion) have had their foundations in the relationships between human and wildlife, involving emotions promoting respect and admiration (Castillo-Huitrón et al. 2020).

Our study identified that some socio-demographic barriers (age and educational level) as well as cultural and religious could affect the negative attitudes towards bats. These barriers appeared in other studies made in different cultural contexts (e.g., Castilla et al. 2020; Lu et al. 2021; Musila et al. 2018; Straka et al. 2020); therefore, there seems to have a common pattern in the human attitudes towards this mammal group. These barriers could be avoided with carefully segment and/or specific campaigns addressing different target audiences.

Conclusion

The great bat biodiversity, their role in the ecosystem's health and their economic importance reveal the need for a global conservation and management plan for them. At present, as presumed reservoirs of diverse viruses, these species are involved in a deep conflict with human populations. Many people, due to ignorance, fear, myths or beliefs, have negative attitudes towards bats. Society's emotions or attitudes towards wildlife may be key elements for decision-making on conservation issues (Castillo-Huitrón et al. 2020). Our study highlights the importance of socio-demographic and religiousness variables to understand the human attitudes towards bats and shows the role of visual information and aesthetic appeal in

fostering positive attitudes. The results demonstrate that positive attitudes towards bats can be encouraged by using informative videos and images of bats with attractive aesthetics. Our findings allow the development of new communication strategies for bat conservation associations keeping in mind the importance of human attitudes to get their goals and to favour bat-friendly behaviours.

Conflict of interest

The authors declare no conflict of interest.

Ethics statement

Ethical review and approval were not required for the study on human participants in accordance with the local legislation. The participants provided their written informed consent to participate in this study.

Author contributions

Conceptualization, A.B. and F.L.; methodology, B.P. B.Á., J.C.I., A.B.; validation, B.P. and B.Á.; formal analysis, B.P. and F.L.; investigation, A.B., J.C.I. and F.L.; resources, funding and project administration F.L. and A.A.; writing—original draft preparation, B.P., A.B. and F.L.; writing—review and editing, B.Á., A.A. and F.L. All authors have read and agreed to the published version of the manuscript.

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Supporting information

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

Appendix S1. Sociodemographic characteristics of the sample and country of residence of the participants.

Appendix S2. Experimental condition for our study, where the participants randomly received one of the following stimuli: Stimulus 1: Picture (a) shows a panda bat (*Niumbaha superba*) which is considered aesthetically attractive. Stimulus

2: Picture (b) shows a vampire bat (*Desmodus rotundus*) which is considered an unattractive species. Stimulus 3: Informational video (c) with a duration of 72 seconds and with different snapshots of animated bats and information about their benefits of bats for agriculture. Stimulus 4: The participants did not receive any stimulus, conforming the control group.

Appendix S3. (a) Differences between the gender of participants and the human attitudes toward bats. The figure includes the statistical analysis applied. (b) Differences between the educational level of participants and the human attitudes toward bats. The figure includes the statistical analysis applied. (c) Differences between the people who have had a real experience with bats and those who had not. The figure includes the statistical analysis applied. (d) Differences between the religiousness of participants and the human attitudes toward bats. The figure includes the statistical analysis applied.