

Vampires Are Still Alive: Slovakian Students' Attitudes toward Bats

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ABSTRACT Animals that pose a threat of disease are often in conflict with human appreciation of them, despite that they may be endangered in nature. This study examined undergraduate students' knowledge of, attitudes toward, and belief in myths about, bats, controversial animals well known both from mythology and movies. Factor analysis was applied to 46 Likert-type items (Bat Attitude Questionnaire) and five dimensions with high reliability ($\alpha = 0.93$) were derived. It was found that the level of knowledge significantly influenced attitudes to, and belief in myths about, bats. Students more aware of the biology of bats showed more positive attitudes to them and less belief in myths about them than students with less knowledge of the biology of the bat. Males showed greater knowledge of bats than females, but even after controlling for the effect of knowledge, females had slightly more negative attitudes toward bats and greater belief in myths about them than did males. A substantial number of students reported a serious fear of bats. Myths about bats were very pervasive in all subgroups, being similarly distributed amongst biology majors and non-majors. These results suggest that greater public awareness could balance human avoidance of bats, something that is promoted by an evolutionary predisposition to avoid potential disease threats. Effective interventions and public awareness should therefore result in more positive attitudes toward these controversial animals.

Keywords: animals, attitudes, bats, myths



Fear of animals has traditionally been viewed as a biological predisposition that associates humans with potentially dangerous animals with fearful consequences (Seligman 1971). Some animals still agitate fear and initiate defensive responses (Öhman 1986) because they might have been dangerous to humans in prehistoric times (Morris and Morris 1965; Shepard 1997). Nevertheless, there are many fears

of non-predatory, “disgusting animals” such as cockroaches, spiders, rats, and bats (Matchett and Davey 1991). This phenomenon is currently explained by the “disease-avoidance” hypothesis (Matchett and Davey 1991; Davey 1994; Davey et al. 1998; Curtis, Aunger and Rabie 2004). This hypothesis comprises three subcategories. The first subcategory deals with fears of animals that are directly or indirectly associated with the spread of disease and infection (e.g., bats, rats, mice). The second subcategory refers to those animals that possess features which resemble primary disgust-evoking stimuli such as mucus or feces (e.g., snakes, snails, worms). The third subcategory relates to those animals that are either contingently associated with dirt, disease, or infection, or act as signal for dirt, disease, and infection (e.g., spiders). Davey et al. (1998) argue that although disgust evolved to prevent oral ingestion of potentially noxious materials, it also operates to prevent infection from the above-mentioned animals.

This brief description of fear of animals implies that human views of animals are influenced by direct and indirect selection pressures (Herzog and Burghardt 1988). Predators are less appreciated because they possess predation risk to humans (Røskaft et al. 2003) and some other animals are directly or indirectly associated with risk from infection and disease (Davey et al. 1998). Bats are, together with bugs, mice, and snakes, the most frequently cited category of phobic fears (Robins and Regier 1991). Fear of bats can be explained both by direct pressures characterized by association with disease, especially parasites and rabies (e.g., Whitaker and Douglas 2006; Wong et al. 2007), and media representation of bats as animals to be feared. Both of these pressures are, however, highly exaggerated. For example, Whitaker and Douglas (2006) tested 8,262 bats for rabies and found that only 5.4% of them were positive for the disease. Moreover, only a minority of bat species transmit diseases that constitute a serious health risk (Olnhausen and Gannon 2004). Horror films that present bats as vampires are also far from the truth—only three of about 1000 bat species in the world suck blood and these pose no serious threat to humans (Mayen 2003).

Low sympathy with bats probably did not evolve just through direct evolutionary pressures, considering that the incidence of being infected from bats is low for humans and infected bats are not clustered in small areas (unlike what occurs in terrestrial forms of rabies) (Williams and Barker 2001). More probably, there might be an interaction between evolutionary pressures and the unusual habits of bats. Bats are the only flying mammals (and therefore frequently misclassified as birds, see Prokop, Kubiak and Fančovičová 2007), they sleep during the daytime in not very accessible places (e.g., caves), and usually hang upside down from a high and secluded spot. Bats have backward feet, thumb hooks, and enormous ears. In addition, unlike humans or birds, bats do not use audible acoustic signals for communication. We know that similarity between animals and humans affects peoples' evaluation of animals. For example, Plous (1993) found that the level of human-to-animal similarity is linked to an individual's judgment about the capacity for an animal to feel pain. Knight et al. (2003) showed that humans prefer animals that are perceived as more similar physically to humans, while animals that look different to us are viewed more negatively. Allen et al. (2002) showed that there is a positive, linear relationship between the fines recommended for animal abuse and the similarity of the animal to humans. Taking bat morphology and natural history into account, there is very little overlap in the coexistence between humans and bats, which makes bats less familiar to humans than other mammals and even birds.

Gaining an understanding of the biology of bats was difficult not just for the general public (Strohm 1982); it was also difficult for scientists. Lazzaro Spallanzani (1729–1799), an Italian priest and physiologist, tried to explain the ability of bats to navigate in darkness and found that

blindfolded bats could navigate but that they bumped against obstacles when their mouths were covered. At this time, he did not discover the echolocation navigation system of bats; instead “Spallanzani’s bat problem,” as it was termed, remained a scientific mystery until 1938, when Harvard students Donald R. Griffin and Robert Galambos (1941) used a sonic detector to record directional ultrasound noises being emitted by bats when navigating flight.

Considering our lack of understanding of these animals, it is not surprising that bats evoke little sympathy (Davey et al. 1998; Bjerke and Østdahl 2004). By the late 1970s and early 1980s, leading newspapers and magazines published stories that bore no resemblance to reality (Okie 1979; Cox 1980), and frightened people into extreme intolerance of bats. Today, bat numbers are declining all over the world (e.g., Lane, Kingston and Lee 2006). This is disturbing, as these animals are major insect-controllers and pollinators in ecosystems worldwide. Many species are becoming endangered, and others are declining due to destruction of their nesting caves, direct persecution from ignorance, closure of mines which many bats had colonized, and indiscriminate use of pesticides (Fujita 1991). An alarming decline in the number of bats in Slovakia has resulted in protection of all species.

Fear of something traditionally generates various myths that are more or less appreciated by humans (Isbister 2002). Myths are identical to *alternative conceptions*: peoples’ concepts of natural phenomena that often differ from those of scientists (e.g., Mintzes and Wandersee 1998). To date, there have been several papers investigating peoples’ alternative conceptions of animals (Prokop, Kubiak and Fančovičová 2007; Prokop, Prokop and Tunnicliffe 2008). Mintzes and Wandersee (1998) characterize alternative conceptions as follows: Alternative conceptions are robust with respect to age, ability, gender, and cultural boundaries. They typically serve a useful function in the everyday lives of students, their families, and their teachers. Alternative conceptions are often tenacious and resistant to change by conventional teaching strategies. They successfully interact with knowledge presented in formal instruction and often resemble those of previous generations of scientists and natural philosophers. Alternative conceptions are products of personal experiences or the mass media, as well as formal instructional interventions (Mintzes and Wandersee 1998).

Teachers are known to be responsible for various misunderstandings in their pupils (Yip 1998). Thus, future teachers’ knowledge of, and attitudes toward, animals needs to be improved. To date, however, it is not known whether peoples’ belief in common myths about animals influences attitudes toward animals (Prokop and Tunnicliffe 2008). Additionally, there are no studies that have seriously investigated attitudes toward bats, with the exception of studies of fear of bats (e.g., Davey et al. 1998). Measurements of human sympathies with animals, indicating how much some selected animal species are liked or disliked (e.g., Davey et al. 1998; Bjerke, Østdahl and Kleiven 2003; Bjerke and Østdahl 2004), do not tell us if greater sympathy is linked with the role of particular animals in nature (ecologicistic attitudes, cf. Kellert 1996), information which could be used in nature protection programs. Moreover, few research studies have addressed the question of whether the level of knowledge of controversial animals is linked with attitudes toward them (Thompson and Mintzes 2002). Bjerke, Østdahl and Kleiven (2003) showed that pet owners (i.e., probably more knowledgeable participants, see Prokop, Prokop and Tunnicliffe 2008) ranked popular animals more positively than non-pet owners, but no effect of owning a pet on the preference of less popular animals like bats or rats was found. This suggests that there is a conflict between the human evolutionary predisposition to avoid animals that present a disease risk (e.g., mice, bats) and animal protection attitudes which are required to save biodiversity. Bats are excellent model animals

to use in the study of this conflict: their population is declining all over the world and they can transmit rabies to humans.

We also chose to focus on bats in our study because, through horror films, they have a very bad reputation, and because they are characteristic of a wide group of animals that might benefit substantially from effective conservation education programs. We believe that the general public can aid in the preservation of bats by protecting old buildings or trees, or by building bat boxes.

Current Study

The present study aimed to examine relationships between attitudes toward, knowledge of, and belief in myths about, bats in undergraduate students who were studying to become primary or secondary school teachers. We thought the information would be useful in designing environmental programs to promote bat conservation. Attitudes were examined in biology majors, while non-majors served as a "control group" for comparison, to see if they have better knowledge of, and more positive attitudes toward, bats. We also compared whether the proportion of students who believed in myths was different among biology majors and non-majors. The link between attitudes, knowledge, and belief in myths will be of interest to environmental educators and may help them to improve interventions focused on less popular animals.

The aim of our research was to answer the following research questions: 1) What knowledge of, attitudes toward, and beliefs in myths about, bats do Slovakian students have? 2) Is knowledge of bats related to attitudes toward bats? 3) Are there any differences in knowledge of, and attitudes toward, bats with respect to gender? and 4) Are there any differences in attitudes toward, knowledge of, and belief in myths about, bats between biology majors and non-majors?

We developed three hypotheses:

Hypothesis 1: Belief in myths about bats and poor knowledge of bats will result in negative attitudes toward bats.

Hypothesis 2: Females will have more negative attitudes toward bats compared with males. This is because females show greater investment in future offspring, thus their concern about potential disease threats should be higher.

Hypothesis 3: Considering the nature of myths (or alternative conceptions), we do not predict any differences in belief in myths about bats between biology majors and non-majors, despite that knowledge of bats will be higher among the former group of students. This is because myths are tenacious and resistant to change by conventional teaching strategies (Mintzes and Wandersee 1998).

Methods

Construction of the Bat Attitude Questionnaire (BAQ)

Students' attitudes toward, belief in myths about, and knowledge of, bats were measured using 5-point Likert-type items, developed in a similar way to Kellert's (1996) attitudes toward animals scale. Most of the negativistic items that measured dislike and fear of bats were derived and modified from the Spider Phobia Questionnaire (Kindt, Brosschot and Murit 1996). Items from this questionnaire were made appropriate by simply changing the term "spider" to "bat." Knowledge of bats was measured by items that represent basic facts about the biology of bats. Myths about bats were derived from accessible online web pages, publications (Strohm 1982), and our own experience with peoples' beliefs. Other attitude items were taken from Kellert (1996) and similar research (e.g., Thompson and Mintzes 2002; Barney, Mintzes and

Yen 2005)—we aimed to measure Negativistic, Scientific, and Ecologistic attitudes. The Negativistic questions were designed specifically to measure an active avoidance of bats as a result of dislike or fear. The Scientific questions were designed to measure interest in the biology of, and the gathering of information on, bats. Ecologistic questions were designed to investigate participants' concern for the role of bats in nature and for inter-relationships between bats and humans. The original questionnaire consisted of 57 items which were scored by participants from 1 (strongly disagree) to 5 (strongly agree). Items were formulated either negatively or positively (Oppenheim 1999). Negative items were scored in reverse order, and summed scores provided a composite index of attitudes toward bats. Low scores reflected relatively negative attitudes and high scores reflected positive attitudes toward bats.

The validity of the questionnaire was established through review by two professors in the field of zoology from two different universities and two experts in biology education. All were asked whether the items were relevant to the goal of the questionnaire. Revisions were based on their comments and suggestions. The results of a pilot study, in which 60 university students participated, were carefully reviewed. Eleven items that did not correlate with other items (Pearson's $r \geq 0.2$) were excluded, according to Salta and Tzougraki (2004).

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. Large values for the KMO measure indicate that a factor analysis is appropriate. In our research, the Kaiser-Meyer-Olkin measure of sampling adequacy was greater than 0.90. Another indicator of the strength of the relationship among variables is Bartlett's Test of Sphericity. This is used to test the null hypothesis that the variables in the population correlation matrix are uncorrelated. The observed significance level was $p < 0.001$. It was therefore concluded that the strength of the relationship among the variables was strong. This meant we could use factor analysis to analyze the data.

Factor analysis was conducted on data from the final study (Principal Components Analysis with Varimax rotation) and seven factors with eigenvalues greater than 1.0 were derived. After examination of the scree-plot, we decided to use five of the seven factors, accounting for 46% of the variance, following the procedure of Salta and Tzougraki (2004). The five factors were subjected to a Varimax rotation, resulting in five independent factors¹. These were labeled Negativistic, Scientific, Ecologistic, Knowledge, and Myths. Finally, we measured the reliability of all items and also the reliability of each dimension separately. The Cronbach's α coefficient for the whole instrument was 0.93, which indicates high reliability (Nunnally 1978). All dimensions showed acceptable reliability (alphas ranged from 0.63 to 0.92) (Nunnally 1978), but the alpha for the Knowledge dimension was somewhat lower ($\alpha = 0.56$). Thus, some caution must be made when interpreting these data.

Participants

A total of 236 first-year students (159 females, 77 males) aged 18–24 years (mean = 19.5, $SE = 0.06$), and attending two different universities in Slovakia, participated in the study. Because this research was conducted in educational faculties where a strong female bias historically exists, it was impossible to balance the female to male ratio. Students were studying to become primary or secondary school teachers. They studied various disciplines, with a significant proportion of the group (41%) enrolled in a biology course. To minimize the effect of age, only first-year students were selected for this study. Students had experience mainly with general biology courses, and not with general zoology or vertebrate zoology courses. The

remaining 139 students were enrolled mostly in humanities disciplines. This allowed us to compare potentially more (biology majors) and less (students enrolled in humanities) interested/educated students in terms of their attitudes toward, knowledge of, and beliefs in myths about, bats. Effect sizes were estimated by Cohen's d , following the suggestion of Herzog (2007).

Procedure

The questionnaires were administered during October and December 2006 in lecture theatres, and students completed them there on their own. It was explained to the students that the questionnaire was not a test, but rather research examining attitudes toward bats. It took about 20 minutes for the students to complete the questionnaire. A total of 250 questionnaires were distributed; out of these, 236 (94%) were returned.

Results

An Analysis of Students' Knowledge of, and Belief in Myths about, Bats

Overall, students showed some incorrect knowledge of, and belief in myths about, bats. The mean overall success was 42.3% ($SE = 4.33$, range = 17–68%). Only 27% of students gave correct responses, with a mean score of 4 or 5, in the Knowledge dimension. The Myths dimension was somewhat better answered (43% positive responses) than the Knowledge dimension (Chi-square test with “don't know” responses omitted, $\chi^2 = 114.95$, $df = 1$, $p < 0.001$). Importantly, a majority of respondents in the Knowledge (73%) and Myths dimensions (56%) were undecided. Only 17% of all students knew that bats in Slovakia overwinter without feeding. Less than 30% knew the size of bat wings and only 42% knew that the body length of bats in Slovakia does not exceed 8 cm. Only 39% of students knew that some tropical bats feed on fruit. Perhaps surprisingly, only 41% of students knew that the protection of old buildings and trees contributes to bat conservation.

Just over half (55%) of all the students believed that a bat can get tangled in human hair. Other myths were focused mainly on vampirism. About 20% of all students believed that most bats feed on blood. This is not true—only three species of bat exclusively suck blood from animals (but not from humans). Feeding habits of bats were not well understood: less than half (41%) of the students knew that all bats in Slovakia are insectivorous. About one-third (36%) of students believed that even small bats can bite a hand. Only 11% believed that bats can suck blood from humans. Seven percent of students agreed that the prey of a bat can lose all its blood after the bat has preyed upon it. This is untrue—bats suck only a small amount of blood very cautiously from sleeping animals that usually do not notice the sucking bat. A majority of the students (68%) did not believe that bats bite their victim's neck. This is also a myth—bats need a less sensitive part of the animal body, to suck blood unobtrusively.

An Analysis of Students' Attitudes toward Bats

The distribution of positive and negative attitudes significantly differed between the three remaining dimensions ($\chi^2 = 29.9$, $df = 2$, $p < 0.001$; see Figure 1). Most positive responses (pooled data from “agree” and “strongly agree”) were found in the Ecologicistic dimension (80%), followed by the Scientific dimension (52%), and finally the Negativistic dimension (42%). This means that there was greatest concern for the role of bats in nature and human–bat relationships. Interest in the biology of bats and avoidance of bats was somewhat lower.

The Negativistic Dimension: The distribution of means shows that 24% of students had negative attitudes toward bats and 34% were undecided (Figure 1). The items with low mean

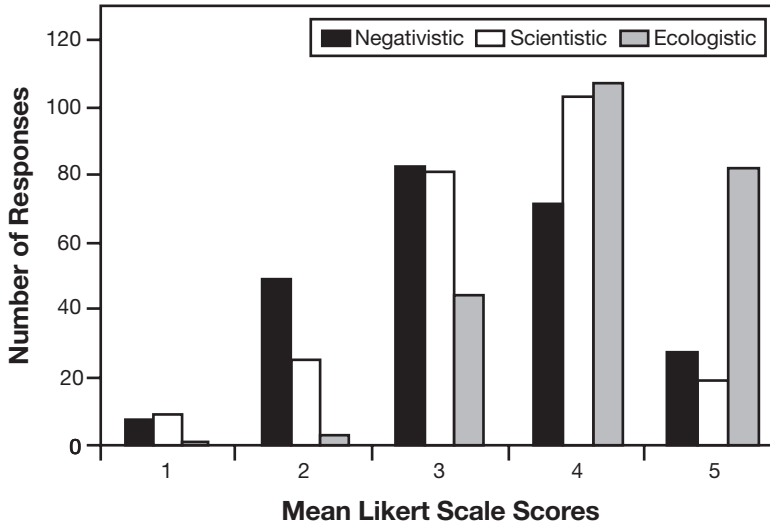


Figure 1. Distribution of overall mean scores of the Negativistic, Scientific, and Ecologistic attitude dimensions.

scores (indicating negative attitudes) are described as follows: Only 9% of all students agreed that they wanted to have bats in the loft of their homes; about one-third (39%) of all students considered bats to be popular animals; a majority (65%) of students did not want to camp near places inhabited by bats (only 22% agreed); 57% did not want to catch a bat in their hands; 34% of students said that even the thought of touching a bat scared them; 15% reported having greater fear of bats than of other animals, and 25% felt tense if they saw a bat.

The Scientific Dimension: Only 33 students showed negative attitudes toward bats in the Scientific dimension (Figure 1). The best responses were found for the item “Bats could be quite interesting animals” (81% agreed). Similarly, 72% of students agreed that greater attention should be dedicated to bat protection, and only 16% said that they couldn’t understand how anyone could be interested in bat research. In contrast, just 35% of students would have liked to have participated in an expedition focused on bat research.

The Ecologistic Dimension: Students showed highest mean scores in the Ecologistic dimension, relative to the other dimensions (Figure 1). Only 3% of all students agreed with the statement that bats are not important in nature. The majority of students (80%) knew that bats overwinter in abandoned caves and tunnels and that bats are of great importance in nature (58%). Only 21% of students were not interested in whether bats were endangered in Slovakia.

Effects of Gender and Attending a Biology Course on Students’ Knowledge of, and Attitudes toward, Bats

A Nested-Design-MANOVA (gender differences nested in study course were defined as factors) with the Scientific, Ecologistic, Negativistic, Myths, and Knowledge dimensions defined as dependent variables, showed that both gender ($F_{(10,456)} = 8.02, p < 0.0001, \eta^2 = 0.15$) and study course ($F_{(6,228)} = 3.39, p = 0.006, \eta^2 = 0.07$) significantly influenced the mean score on the BAQ dimensions. Inspection of univariate results revealed that males had significantly

higher scores than females in four dimensions (the Negativistic dimension: $F_{(2,232)} = 26.58$, $p < 0.0001$, $d = 0.99$, the Ecologistic dimension: $F_{(2,232)} = 3.40$, $p = 0.03$, $d = 0.30$, the Knowledge dimension: $F_{(2,232)} = 16.49$, $p < 0.0001$, $d = 0.72$, and the Myths dimension: $F_{(2,232)} = 6.27$, $p = 0.003$, $d = 0.48$), with the exception of the Scientistic dimension ($F_{(2,232)} = 2.50$, $p = 0.08$, $d = 0.18$) (Figure 2). These results support our second hypothesis, that females will have more negative attitudes toward bats than males.

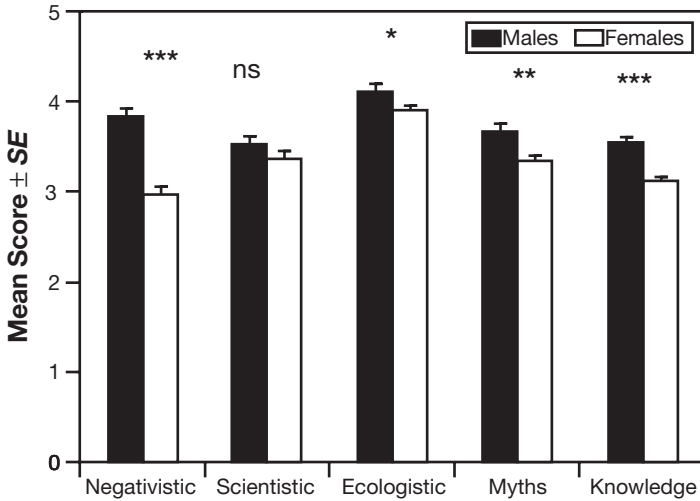


Figure 2. Differences between male and female students on the five dimensions derived from the Bat Attitude Questionnaire. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = non-significant.

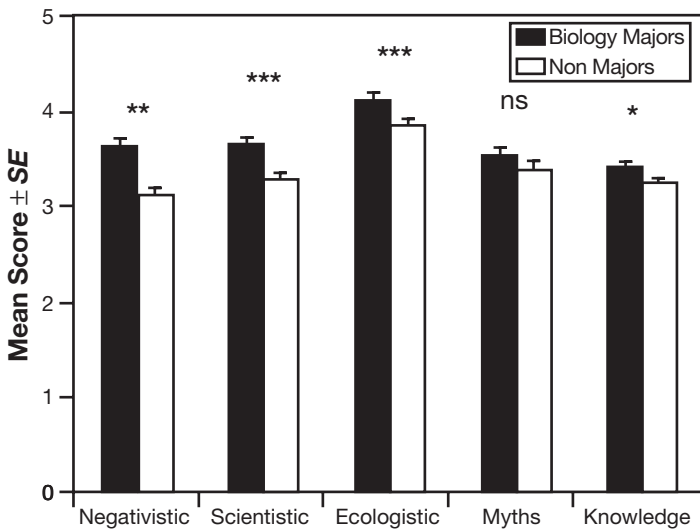


Figure 3. Differences between biology and non-biology major students on the five dimensions derived from the Bat Attitude Questionnaire. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = non-significant.

Students attending biology courses scored higher in the majority of BAQ dimensions (the Negativistic dimension: $F_{(1,232)} = 7.64$, $p = 0.006$, $d = 0.32$, the Scientific dimension $F_{(1,232)} = 13.57$, $p = 0.0003$, $d = 0.43$, the Ecologicistic dimension, $F_{(1,232)} = 10.43$, $p = 0.001$, $d = 0.38$, and the Knowledge dimension: $F_{(1,232)} = 3.88$, $p = 0.04$, $d = 0.21$). Only the Myths dimension did not show a statistically significant difference ($F_{(1,232)} = 2.48$, $p = 0.12$, $d = 0.20$) (Figure 3). The latter result supports our third hypothesis, that there will be no differences in beliefs in myths about bats between biology majors and non-majors.

Relationships between the Knowledge, Myths and Attitude Dimensions

After controlling for the effect of gender and attendance of biology course, statistically significant, positive relationships between all measured dimensions were found (Table 1). The strongest correlation was found between the Negativistic and Scientific attitudes, which suggests that fear of bats influences interest in the biology of bats. Importantly, belief in myths about bats was correlated with the Negativistic dimension, which suggests that there is an association between belief in myths and fear and avoidance of bats. Knowledge of bats correlated strongly with the Negativistic and Ecologicistic dimensions, which suggests that greater awareness of the biology of bats is associated with other dimensions of attitudes toward them. Associations between knowledge, myths and attitudes support our first hypothesis, that belief in myths about bats and poor knowledge of bats will result in negative attitudes toward them.

Table 1. Relationships between the dimensions derived from the Bat Attitude Questionnaire. Numbers are partial correlation coefficients ($p < 0.0001$ for all dimensions) controlled for the effect of gender and attendance of biology course.

	Scientific	Ecologicistic	Knowledge	Myths
Negativistic	0.61	0.35	0.34	0.43
Scientific	–	0.43	0.30	0.25
Ecologicistic		–	0.36	0.33
Knowledge			–	0.30

Discussion

This study shows the importance of factual knowledge, myths, study specialization and gender in students' attitudes toward bats. We have demonstrated that there is a relationship between knowledge, belief in myths, and attitudes, which corroborates the results of some other research (for links between attitudes and knowledge, see Kellert 1993; Thompson and Mintzes 2002; Barney Mintzes and Yen 2005; Prokop, Kubiato and Fančovičová 2008). This finding is very important because it shows that greater knowledge of bats and less belief in myths is linked with positive attitudes toward controversial animals like bats, which are considered “disgusting,” due to the human evolutionary predisposition toward potential disease threats (Davey et al. 1998; Curtis, Aunger and Rabie 2004). Biology majors had better knowledge of, and more positive attitudes toward, bats than the non-biology major students, even though they had not studied zoology. This suggests that students' attitudes are influenced by well-developed individual interest (sensu Renninger 2000), not by the effect of study course per se. Well-developed individual interest is a relatively enduring predisposition to re-engage with particular classes of subject matter over time. A student with a well-developed individual interest in a subject has more stored knowledge and stored value for that subject than he or she has for other subjects.

Both attitudes and knowledge were heavily influenced by gender differences. In general, research has shown that females exhibit greater interest in rearing pets (Prokop, Prokop and Tunnicliffe 2008) and have more positive attitudes toward animal protection than males (Herzog 2007). However, females also show greater fear of carnivores (Røskaft et al. 2003), spiders (Davey 1994), and prefer “popular” species of animals, whilst males like less popular animals such as snails, bats, and rats (Bjerke and Østdahl 2004). These patterns are consistent with our findings—females showed less knowledge of, and more negative attitudes toward, bats. However, no differences in the Scientific dimension with respect to gender were found. Negative attitudes toward bats in females are consistent with women’s enhanced evolutionary role in protecting the next generation (Røskaft et al. 2003, Curtis, Aunger and Rabie 2004). This means that females might fear not only for their own safety from a disease threat, but for the safety of their children, as well. Further research with a more diverse sample (both with mothers and childless females) would shed more light on this topic.

Although biology majors showed more positive attitudes toward, and knowledge of, bats than non-biology majors, it should be noted that belief in myths about bats were similarly distributed amongst both groups. This finding is intriguing and tells us something of the pervasive power of myths, which have been found to be often resistant to conventional teaching approaches (Mintzes and Wandersee 1998)—the attention of biology/science teachers and environmental protectors is therefore required. We suggest that the main problem in human perceptions of bats is poor understanding of feeding habits and the size of bats. These suggestions are supported by the fact that a significant proportion of the students were not aware that an overwhelming majority of bats do not feed on blood (Kubiátko and Prokop 2007). Vampire bats generally drink from cattle and other large herbivores and present no danger to humans. Naive ideas about the real size of bats, which are usually magnified in horror films, would also contribute to fears of bats and their potential danger to humans. That more than half of the students in our study still believed that bats can get tangled in human hair clearly indicates that myths still influence the beliefs of people in modern societies.

From an environmental, educational perspective, bats are unique animals that are virtually never kept as pets by school-age children (Prokop, Prokop and Tunnicliffe 2008). The problem is that they fly at night, and, as found in the present study, a substantial number of students suffer serious fear of them. Thus, observing or keeping bats is much harder than, for example, bird watching, and planning environmental activities focused on bat conservation should take these facts into account. A strong correlation between the Scientific and the Negativistic dimensions in our study suggests that chiropterology (the study of bats) should be made available to people, particularly students. This should result in an increased appreciation of bats.

Informal biology settings can encompass discussions with professional chiropterologists, members of protection communities, and field trips. An important issue is students’ physical contact with bats. This is because physical contact with particular, even disgusting, animals influences students’ interest more strongly than non-contact interventions (Morgan and Gramman 1989). Field trips need be designed to consider the nocturnal activity of bats. At best, special capture nets (like ornithological ones) can be attached to the entrance of caves inhabited by bats. After catching a bat, ultrasonic bat detectors that convert the ultrasonic calls of bats into sounds that are clearly audible to humans can be used. Other activities can be focused on observations of overwintering bats in selected caves.

Our own experience tells us that all the activities described above can have a strong influence on motivating students of various ages. The effect of knowledge on attitudes toward bats and belief in common myths about bats shown in this study has direct implications for teaching biology/science and bat protection. We hope that this paper will encourage both nature protectors and researchers from different countries to conduct comparative research in this area. This will contribute to a deeper understanding of relationships between humans and animals.

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Note

1. The full version of the Bat Attitude Questionnaire (BAQ), along with detailed information about the reliability of each dimension, can be found on the first author's web page (www.zoo.sav.sk/prokop).

References

- Allen, M. W., Hunstone, M., Waerstad, J., Foy, E., Hobbins, T., Wikner, B. and Wirrel, J. 2002. Human-to-animal similarity and participant mood influence punishment recommendations for animal abusers. *Society & Animals* 10: 267–284.
- Barney, E. C., Mintzes, J. J. and Yen, C-F. 2005. Assessing knowledge, attitudes and behavior toward charismatic megafauna: The case of dolphins. *Journal of Environmental Education* 36: 41–55.
- Bjerke, T. and Østdahl, T. 2004. Animal-related attitudes and activities in an urban population. *Anthrozoös* 17: 109–129.
- Bjerke, T., Østdahl, T. and Kleiven, J. 2003. Attitudes and activities related to urban wildlife: Pet owners and non-owners. *Anthrozoös* 16: 252–262.
- Cox, C. 1980. The nightmare house. *Family Circle* 93: 64–94, 1 April.
- Curtis, V., Aunger, R. and Rabie T. 2004. Evidence that disgust evolved to protect from risk of disease. *Proceedings of the Royal Society of London, Ser. B* 271: S131–S133 Suppl. 4.
- Davey, G. C. L. 1994. The 'disgusting' spider: The role of disease and illness in the perpetuation of fear of spiders. *Society & Animals* 2: 17–24.
- Davey, G. C. L., McDonald, A. S., Hirisave, U., Prabhu, G. G., Iwawaki, S., Jim, C. I., Merckelbach, H., de Jong, P. J., Lejny, P. W. L. and Reimann, L. 1998. A cross-national study of animal fears. *Behaviour Research and Therapy* 36: 735–750.
- Fujita, M. S. 1991. Flying Fox (*Chiroptera: Pteropodidae*) pollination, seed dispersal, and economic importance: A tabular summary of current knowledge. Resource Publication No. 2, Bat Conservation International.
- Griffin, D. R. and Galambos, R. 1941. The sensory basis of obstacle avoidance by flying bats. *Journal of Experimental Zoology* 86: 481–506.
- Herzog, H. 2007. Gender differences in human–animal interactions: A review. *Anthrozoös* 20: 7–21.
- Herzog, H. and Burghardt, G. M. 1988. Attitudes toward animals: Origins and diversity. *Anthrozoös* 1: 214–222.
- Isbister, G. K. 2002. Data collection in clinical toxicology: Debunking myths and developing diagnostic algorithms. *Journal of Toxicology–Clinical Toxicology* 40: 231–237.
- Kellert, S. R. 1993. Values and perceptions of invertebrates. *Conservation Biology* 7: 845–855.
- Kellert, S. R. 1996. *The Value of Life; Biodiversity and Human Society*. Washington DC: Island Press.
- Kindt, M., Brosschot J. F. and Murit, P. 1996. Spider phobia questionnaire for children (SPQ-C): A psychometric study and normative data. *Behaviour Research and Therapy* 34: 277–282.
- Knight, S., Nunkoosing, K., Vrij, A. and Cherryman, J. 2003. Using grounded theory to examine people's attitudes toward how animals are used. *Society & Animals* 11: 307–327.
- Kubiatko, M. and Prokop, P. 2007. Pupils' misconceptions about mammals. *Journal of Baltic Science Education* 6: 5–14.
- Lane, D. J. W., Kingston, T. and Lee, B. P. Y. H. 2006. Dramatic decline in bat species richness in Singapore, with implications for Southeast Asia. *Biological Conservation* 131: 584–593.

- Matchett, G. and Davey, G. C. L. 1991. A test of a disease-avoidance model of animal phobias. *Behaviour Research and Therapy* 29: 91–94.
- Mayen, F. 2003. Haematophagous bats in Brazil, their role in rabies transmission, impact on public health, livestock industry and alternatives to an indiscriminate reduction of bat population. *Journal of Veterinary Medicine, Ser. B—Infectious Diseases and Veterinary Public Health* 50: 469–472.
- Mintzes, J. J. and Wandersee, J. H. 1998. Research in science teaching and learning: A human constructivistic view. In *Teaching Science for Understanding*, 60–94, ed. J. J. Mintzes, J. H. Wandersee and J. D. Novak. Orlando, FL: Academic Press.
- Morgan, J. M. and Gramann, J. H. 1989. Predicting effectiveness of wildlife education programs—A study of students' attitudes and knowledge toward snakes. *Wildlife Society Bulletin* 17: 501–509.
- Morris, R. and Morris, D. 1965. *Men and Snakes*. London: Hutchinson & Co.
- Nunnally, J. 1978. *Psychometric Theory*. New York: McGraw-Hill.
- Öhman, A. 1986. Face the beast and fear the face: Animal and social fears as prototypes for evolutionary analyses of emotion. *Psychophysiology* 23: 123–145.
- Okie, S. 1979. Warning: Sick bird may be a rabid bat. *Washington Post*, 20 Sept.
- Olnhausen, L. R. and Gannon, M. R. 2004. An evaluation of bat rabies prevention in the United States, based on an analysis from Pennsylvania. *Acta Chiropterologica* 6: 163–168.
- Oppenheim, A. N. 1999. *Questionnaire Design, Interviewing and Attitude Measurement*. New edn. London: Continuum International Publishing Group.
- Plous, S. 1993. The role of animals in human society. *Journal of Social Issues* 49: 11–52.
- Prokop, P., Kubiátko, M. and Faňčovičová, J. 2007. Why do cocks crow? Children's concepts about birds. *Research in Science Education* 37: 393–405.
- Prokop, P., Kubiátko, M. and Faňčovičová, J. 2008. Slovakian pupils' knowledge of, and attitudes toward, birds. *Anthrozoös* 21:221–235.
- Prokop, P., Prokop, M. and Tunnicliffe, S. D. 2008. Effects of keeping animals as pets on children's concepts of vertebrates and invertebrates. *International Journal of Science Education* 30: 431–449.
- Prokop, P. and Tunnicliffe, S. D. 2008. “Disgusting” animals: Primary school children's attitudes and myths of bats and spiders. *Eurasia Journal of Mathematics, Science and Technology Education* 4: 87–97.
- Renninger, K. A. 2000. Individual interest and its implications for understanding intrinsic motivation. In *Intrinsic and Extrinsic Motivation: The Search for Optimal Motivation and Performance*, 373–404, C. Sansone and J. M. Harackiewicz. San Diego, CA: Academic Press.
- Robins, L. N. and Regier, D. A. 1991. *Psychiatric Disorders in America*. New York: The Free Press.
- Røskaft, E., Bjerke, T., Kaltenborn, B. P., Linnell, J. D. C. and Andersen, R. 2003. Patterns of self-reported fear towards large carnivores among the Norwegian public. *Evolution and Human Behavior* 24: 184–198.
- Salta, K. and Tzougraki, C. 2004. Attitudes toward chemistry among 11th grade students in high schools in Greece. *Science Education* 88: 535–547.
- Seligman M. E. P. 1971. Phobias and preparedness. *Behavior Therapy* 2: 307–320.
- Shepard, P. 1997. *The Others*. Washington, DC: Island Press.
- Strohm, B. 1982. Most facts about bats are myths. *National Wildlife* 20: 35–39.
- Thompson, T. L. and Mintzes, J. J. 2002. Cognitive structure and the affective domain: on knowing and feeling in biology. *International Journal of Science Education* 24: 645–660.
- Whitaker, J. O. and Douglas, L. R. 2006. Bat rabies in Indiana. *Journal of Wildlife Management* 70: 1569–1573.
- Williams, E. S. and Barker, I. K. eds. 2001. *Infectious Diseases of Wild Mammals*. 3rd edn. Ames, Iowa: ISU Press.
- Wong, S., Lau, S., Woo, P. and Yuen, K.Y. 2007. Bats as a continuing source of emerging infections in humans. *Reviews in Medical Virology* 17: 67–91.
- Yip, D. Y. 1998. Identification of misconceptions in novice biology teachers and remedial strategies for improving biology learning. *International Journal of Science Education* 20: 461–477.

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