Eurasia Journal of Mathematics, Science & Technology Education, 2008, **4**(2), 87-97

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"Disgusting" Animals: Primary School Children's Attitudes and Myths of Bats and Spiders

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Received 10 June 2007; accepted 07 January 2008

Knowledge of animals may influence children's beliefs and behaviour toward them, thus building positive attitudes toward animals is one of main goals of environmental education programmes. Although keeping animals contributes to the increase of children's positive attitudes toward wild animals, pet owners show similar negative attitudes toward less popular animals such as insects, bats or rats than non-pet owners. Moreover, some of these animals are emblazoned with various myths (hereafter alternative conceptions) which may have a negative impact on children's attitudes toward them. We used a novel approach with two questionnaires with nearly identical items for identifying attitudes to bats and spiders in a sample of primary school participants (N = 196) aged 10 - 16 years. Score from each questionnaire was factor analysed and then compared with a pair-wise statistic. Children (especially girls) showed more negative attitudes toward spiders in comparison with bats. Both knowledge and alternative conceptions were distributed randomly irrespective of children's age or gender. We found a moderate, but significant correlation between alternative conceptions and attitudes, whereas more alternative conceptions resulted in more negative attitudes. Interestingly, the link between attitude and knowledge was found just for bats, but not for spiders perhaps due to greater fear from spiders. Implications of the study for the science education practise are discussed.

Keywords: Alternative Conceptions, Animals, Attitudes, Bat, Myths, Spider

INTRODUCTION

What people feel and believe about the environment determines their attitudes toward it (Pooley, 2000). Although the "feeling" or the affective dimension of science learning has long been recognized as important, it has received much less attention than has the cognitive dimensions (Simpson, Koballa, Oliver, and Crawley, 1994; Alsop and Watts, 2003). Pro-environmental behaviour, however, belies the assumption that behavioral change follows directly from development of necessary knowledge and skills (Iozzi, 1989). Attitudes are expected by some researchers to correlate with knowledge (Thompson and Mintzes, 2002), but there is greater agreement that attitudes correlate with behaviour (Kraus, 1995). The environmental literacy of citizens includes some level of environmental knowledge and attitudes and (pro-environmental) behaviour (Roth, 1992).

Attitudes toward the environment, or the affective dimension, are generally believed to be a more important predictor of pro-environmental behaviour rather than environmental knowledge itself (Iozzi, 1989). An attitude can be generally defined as the tendency to think, feel, or act positively or negatively

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E-ISSN: 1305-8223

toward objects in our environment (Eagly and Chaiken, 1993; Petty, 1995). Social psychologists consider attitudes as having three components: the cognitive, the affective, and the behavioural (see Reid, 2006 for a review). The cognitive component is a set of beliefs about the attributes of the attitudes' object and its assessment is performed using paper-and-pencil tests (questionnaires). The affective component includes feelings about object and its assessment is performed using psychological indices (heart rate). Finally, the behavioural component pertains to the way people act toward the object and its assessment is performed with directly observed behaviours (Eagly and Chaiken, 1993).

The link between environmental attitudes and knowledge

Some researchers propose that environmental knowledge is an essential precursor of attitude formation (Kellert and Westervelt, 1984; Kaiser, Wolfing, and Fuhrer, 1999). However, the relationship between attitude and knowledge is a complex and is still not fully understood (Zimmerman, 1996). Increasing environmental knowledge may result in more positive pro-environmental attitudes. For example, Cohen (1973) found that group of high school students with more environmental information showed different attitudes that the group with less environmental information. Hsu and Roth (1996) investigated the relationship between environmental attitude and knowledge in randomly selected community leaders in Taiwan and found a positive correlation between their environmental knowledge and behaviour. DiEnno and Hilton (2005) compared two teaching methods (constructivistic vs. traditional approach) on high school students' attitudes and knowledge of non-native plants and found that knowledge and attitudes of students experiencing a constructivistic approach significantly increased, while no similar trend was found for the group with traditional approach. Bradley et al. (1999) found that after an environmental science course, students had higher environmental knowledge and attitudes between the pre- and post-tests. In both the pre- and post-tests, students with higher knowledge scores also had higher attitude scores when compared with students who had lower environmental knowledge scores.

Similarly, Mangas and Martinez's (1997) study regarding university students enrolled in an elective environmental education course showed that students' environmental knowledge increased at the end of the course and was accompanied by an increase in environmental attitudes. Initially, the students preferred nature protection values to economic interests.
Later in the course the students espoused other human values (sustainable development and solidarity), demonstrating an apparent shift toward systemic and complex attitudes about environmental matters. Thompson and Mintzes (2002) showed statistically significant relationships among all five knowledge structures (as measured by concept maps) and three of four attitudinal scales.

In contrast, there are several works that failed to find clearly significant relationship between attitude and knowledge. For example, Kuhlemeier et al. (1999) and Makki, Abd-El-Khalick, and Boujaoude (2003) found only moderate correlation between environmental attitude and knowledge. Lukas and Ross (2005) examined attitudes and knowledge toward apes in 1,000 ZOO visitors before and after they visited a zoological garden. They found an increased level of knowledge about apes, but visitors' attitudes toward apes remained unchanged. Only repeat visitors showed more ecoscientistic attitudes than did first-time visitors. Brossard, Lewenstein and Bonney (2005) investigated effects of informal science education project (The Birdhouse Network) on participants' attitude toward science and environment and knowledge about birds. They found that participants' knowledge of bird biology increased in terms of basic facts of biology of birds. However, they failed to find any statistically significant change in participants' understanding of the scientific process, attitudes toward science and attitudes toward the environment. In summary, the link between attitude and knowledge is not definitely resolved yet and, in agreement with earlier view of Kellert and Westervelt (1984), the level of knowledge can be considered as one of several factors affecting attitudes.

Myths and attitudes to animals

Human attitudes toward animals are influenced particularly by the species of animal. For example, the general public were found to view most invertebrates with aversion, anxiety and ignorance (Kellert, 1993), probably because they are small and behaviourally and morphologically unfamiliar to humans (Davey, 1994; Kellert, 1993; Wilson, 1987). Bjerke and Østdahl (2004) found that people most like small animals such as small birds, squirrels, dogs, etc., and dislike invertebrates, bats, rats and mice. Less popular species was more interesting for males and the former group was more popular for females. Similar gender differences (greater fear in females) were also documented relating to human's fears of large carnivore predators (Røskaft, Bjerke, Kaltenborn, Linnell, and Andersen, 2003). This suggests that females should express greater fear from phobic animals in comparison with males. Positive attitudes at least to some animals decrease as age of participants increases (Kellert, 1996; Bjerke and Østdahl, 2004).

Fear from animals has been traditionally viewed as biological predisposition that associates humans with potentially dangerous animal with fearful consequences (Seligman, 1971) or, more recently, by the "disease-avoidance" hypothesis (Davey, 1992, 1994, Davey et al.,

1998). The latter notion comprises a first subcategory of animals that are directly or indirectly associated with the spread of disease and infection (e.g. bats). The second subcategory refers to those animals that possess features which resemble primary disgust-evoking stimuli such as mucus or faeces (e.g. snakes, snails, worms, etc.). The third subcategory relates to animals that are associated with dirt, disease or infection (e.g. spiders).

Fear is traditionally followed by various myths that are more or less appreciated by humans. Myths are identical with alternative conceptions which are often cultural and can be characterized 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).

From the science education perspective, myths or alternative conceptions are especially important in the case of least popular animals such as snakes, spiders or insects, because learners' concepts and/or behaviour towards these animals can be influenced by the negative attitude. For example, Bjerke, Østdahl and Kleiven (2003) showed that, although pet owners have generally more positive attitudes toward wild animals in comparison with non-pet owners, these differences disappeared when comparing attitudes toward less popular animals. This suggests that attitudes to less popular animals can be highly resistant to change.

Purpose of the study

There is at least moderate correlation between achievement and attitudes to science (Haladyna and Shaughnessy, 1982; Weinburgh, 1995; Dhindsa and Chung, 2003; Salta and Tzougraki, 2004). Teaching biology however includes several animal species, such as spiders or bats, generally considered less popular and therefore not reared as pets (Kidd and Kidd, 1985; Prokop, Prokop, and Tunnicliffe, 2008). There are various myths about spiders (Davey, 1994) and bats (Strohm, 1982) which can negatively influence students' attitudes toward them (for attitude classification see e.g. Kellert, 1985, 1996, or Thompson and Mintzes, 2002). Spiders are of especial importance, because it is suggested that up to 1 in 3 females and 1 in 4 males may actively fear spiders (Davey, 1992). To date, however, no systematic approach to examine relationships between various attitude dimensions and alternative conceptions of spiders and bats has been conducted. The present study examines relationships between attitudes, knowledge and myths (referred to as alternative conceptions) in a sample of elementary school children aged 10 -16 year toward two distinct and unique animal groups, bats and spiders, which may be important in a biology curriculum. A comparison of attitudes toward these two distinct animal groups is also interesting, because attitudes that are formed through direct experience are rather affective and attitudes formed through indirect experience are rather cognitively based (Millar and Millar, 1996). Bats are unique examples of animals that agitate fear, but direct experiences with them would be less frequent than that with ubiquitous spiders.

Hypotheses

Our hypotheses were:

1. Attitudes toward spiders would be generally more negative than attitudes toward bats.
2. Boys would have more positive attitudes toward bats and spiders than girls.
3. Attitudes toward both bats and spiders would decrease as age of participants increase.
4. Alternative conceptions (myths) of bats and spiders would be distributed randomly across age classes, but knowledge would show a positive correlation with children's age.
5. Alternative conceptions would influence negative attitudes toward bats and spiders.

METHODS

Construction of the Bat Attitude Questionnaire (BAQ) and the Spider Attitude Questionnaire (SAQ)

We measured students' attitudes towards bats and spiders by Likert-type items (Likert, 1932) developed similarly to Kellert's (1985) attitude scale toward animals. Most of negativistic items were derived and modified following the Spider Phobia Questionnaire (Kindt, Brosschot, and Murit, 1996). Knowledge of bats and spiders was measured by items that represent basic facts about the biology of bats and spiders. Alternative conceptions about bats and spiders were derived from accessible online web pages (putting "myths" + "bats" or "spiders" to google), information from various publications (Airas, unpublished paper; Davey, 1994; Strohm, 1982) and our own experiences with peoples' beliefs. The questionnaire for measuring attitudes, alternative conceptions and knowledge of bats comprised 49 items and the questionnaire for spiders comprised 50 items. Attitude items were identical for both bats and spiders, except for the term "bat(s)" or "spider(s)" which allowed us to use data for pair-wise comparisons. Only in a few instances does the wording of items differ, and this is because it was impossible to design them more accurately (see Appendix A). The

order of items was designed randomly for both two questionnaires. Items that were scored by participants from 1 (strongly disagree) to 5 (strongly agree). Items were formulated either negatively or positively (Oppenheim, 1993). Negative items were scored in the reverse order. Questionnaires were administered on two separate occasions within 1 – 2 days by the classroom teacher. The order of administering the BAQ or the SAQ was random.

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 in each dimension were relevant to the goal of the questionnaire. Revisions were based on their comments and suggestions.

Score from attitudes (31 items in the BAQ and 31 items in the SAQ) was separately submitted to factor analysis (with Varimax rotation). Both BAQ and SAQ showed high reliability of items (Cronbach's alpha = 0.91 and 0.9, respectively). Knowledge and alternative conceptions (remaining 18 items in BAQ and 19 items in SAQ) were measured separately. Six factors with eigenvalues greater than 1.2 for each BAQ and SAQ were derived. These six factors explained 51 and 52 % of total variance. Items with loadings lower than 0.39 were omitted. Items that loaded with more than one factor were also excluded from further consideration (Palaigeorgiou, Siozos, Konstantakis, and Tsoukalas, 2005). As a result, only identical items that loaded to the same dimension for each BAQ and SAQ were used in further analyses. This allowed us to use a pair-wise statistics for comparison of means. In total, data from 5 attitude items for both BAQ and SAQ were omitted. Finally, we measured the reliability of all remaining items (26 items per each questionnaire) and also the reliability of each dimension separately. The Cronbach's alpha coefficient for the whole instrument consisting of 26 items was 0.89 for the BAQ and 0.89 for SAQ which indicates high reliability of the questionnaire (Nunnaly, 1978). The Ecoscientistic dimension consists of 12 dimensions (α = 0.89 for BAQ and 0.87 for SAQ), the Negativistic dimension of 9 items (α = 0.85 for BAQ and 0.87 for SAQ), the Naturalistic dimension of 5 items (α = 0.70 for BAQ and 0.75 for SAQ). The values of Cronbach's alpha showed that all dimensions showed acceptable reliability (Nunnaly, 1978).

Participants

The study was conducted between November and December 2006. A total of 196 grade 5 - 9 children (136 males and 60 females) aged 10 - 16 years (M = 12.2, SD = 1.39) attending two urban elementary schools attending by 6 – 16 years old children participated in the study. Participants were selected randomly irrespective of their interest in biology. Children were satisfied that the questionnaire was not a test, but just a research attempt to examine their attitudes toward bats. No time limit was given during completion of questionnaire.

RESULTS

General differences between attitudes toward bats and spiders

A repeat measures MANOVA was used to identify the effect of gender and grade (between-effect variables) on attitudes toward bats and spiders (within-effect variables). This adds the opportunity of determining through MANOVA which effects are general, and which effects are specific to certain attitude dimension of bat or spider. Results are shown in Table 1.

Overall, there were highly significant differences between six dimensions.

There were more positive attitudes toward bats in comparison with spiders in all three dimensions (Fig. 1) (Hypothesis 1). A Naturalistic dimension showed lower and negative mean score (i.e. mean < 3) in comparison with the Ecoscientistic and Negativistic dimension which suggests that children have low overall interest to encounter these animals (especially spiders) in the nature.

Table 1. Multivariate analysis of variance (MANOVA) of Slovakian children's attitudes toward bats and spiders.

	SS	DF	MS	F	P
Grade	11.16	4.00	2.79	1.23	0.30
Gender	12.98	1.00	12.98	5.72	0.02
Grade × Gender	30.07	4.00	7.52	3.31	0.01
Error	422.36	186.00	2.27		
Attitudes	150.47	5.00	30.09	46.48	0.001
Attitudes × Grade	39.82	20.00	1.99	3.08	0.001
Attitudes × Gender	5.73	5.00	1.15	1.77	0.12
Attitudes × Grade × Gender	10.74	20.00	0.54	0.83	0.68
Error	602.16	930.00	0.65		

Differences in attitudes with respect to gender and grade

Boys have generally more positive attitudes toward bats and spiders than girls (Hypothesis 2). The effect of gender was especially significant in the Negativistic and the Naturalistic attitudes toward spiders (univariate ANOVA, Boys > Girls, $F_{1,186} = 6.6$ and 8.9, $p < 0.01$ and 0.001, respectively).

Attitude dimensions showed different mean score with respect to age of children (Table 1). A Tukey post-hoc comparison of means revealed that 5th and 9th grade boys (10 - 16 years old) showed significantly more positive attitudes toward bats and spiders than girls from the same age category.

The attitude dimensions between bat and spider mutually correlated and correlation coefficients ranged 0.35 – 0.54 (see Figs. 2 – 4). Visual observation of these figures suggests that the Naturalistic and Ecoscientistic attitudes decrease as age of children increase (Hypothesis 3) while the Negativistic attitudes remained more or less unchanged.

Knowledge of bats

More than half of children (56 %) were undecided on the number of bats living in Slovakia. Similarly, about half of children did not know or were undecided what sense use bats when foraging or what is main diet of bats in Slovakia. The majority (70 %) of children was undecided or did not know the size of bats (both body length and patagium length items showed very similar incorrect results). Surprisingly, only 15 % of all children agreed that bats overwinter in Slovakia and do not feed during overwintering. Because just 11 % incorrectly agreed that bats migrate to Africa for overwintering, we suggest that children do not have clear idea not about where, but rather how bats hibernate (i.e. without receiving any food). About half of children (57 %) agreed that bats occur in caves and abandoned tunnels.

Alternative conceptions about bats

Only 17 % of all children rejected an idea that bat can tangle in human hair. Similarly, 37 % of children incorrectly showed that the main diet of bats is blood. A similar number of children thought that bats can prey upon human. Only about one-third of children were right that bats do not attack their prey especially to the neck (like vampires in horror films) or that the prey cannot lose all blood after a bat's attack. A similar number of children rejected an idea that bats rear their young in nests. All these data suggest that Slovakian children's were unsure about biology of bats.

Knowledge of spiders

The majority of children (74 %) did not know, or were undecided, about the number of spiders living in Slovakia. A similar number (69 %) did not know (or were undecided) about the maximal size of spiders in Slovakia or about the number of eyes of the garden spider. However, more than half (57 %) were correct that spiders do not have 10 legs and a similar number agreed that all spiders feed on smaller animals. In contrast, 71 % of children were undecided or did not know that spider species are not vegetarians. Nearly half of children (42 %) correctly rejected an idea that all spiders are insects. Only about one-third (28 %) correctly believe that some female spider rear spiderlings on her own back or do know how spiderlings overwinter (36 %). About 74 % were undecided of the senses which garden spiders use when hunt on prey.

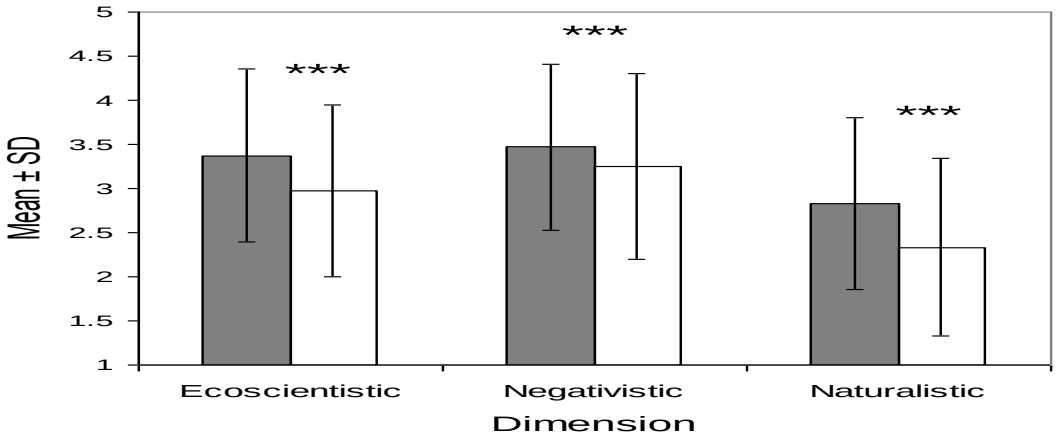

Figure 1. Attitudes toward bats (grey bars) and spiders (open bars) in elementary school children ($n_1 = n_2 = 196$). Differences marked with asterisks (***) are statistically significant (paired t-tests, $p<0.001$).

Alternative conceptions about spiders

Only one third (28 %) of all children is aware that bites of tarantula spiders are not fatal to humans. A similar number (36 %) of children agreed that small spiders do not bite a human. About 37 % of children did not correctly agree that all spiders make orb-webs or that each female spider cannibalizes a male after mating (30 %). A majority of children (62 %) incorrectly believed or were undecided that spiders are dangerous to humans mainly when humans sleep. Only 17 % of all children were correct that a garden spider is unable to repair its orb-web. About half of children (53 %) state that orb-webs are sticky.

Does gender and grade influence children's alternative conceptions and knowledge of bats and spiders?

A two-way ANOVA with gender and grade was used to test whether gender and/or children's age (grade) influence alternative conceptions and knowledge of bats and spiders. Contrary to general expectations, there were very weak relationships between grade and knowledge of bats or spiders ($F_{4,186} = 3.31$ and 0.26, $p = 0.011$ and 0.9). Although the effect of grade / age of children on their knowledge of bats showed a significant effect, this result is of low educational importance, because this significance was caused just by the lower score of 6th graders (age 11/12) relative to others. Gender showed no significant effect ($F_{4,186} = 1.39$ and 1.03, $p = 0.24$ and 0.31).

As expected, alternative conceptions were distributed randomly, irrespective of children's age in both bats and spiders ($F_{4,186} = 0.98$ and 2.19, $p = 0.42$ and 0.07) This finding suggests that Hypothesis 4 (Alternative conceptions of bats and spiders would be distributed randomly across age classes, but knowledge would show a positive correlation with children's age) was just partly supported.

Are alernative conceptions and knowledge linked with attitudes?

A series of Pearson correlation coefficients was conducted to determine relationships between myths, knowledge and attitudes toward bats and spiders. We found that there is a correlation between alternative conceptions about bats and spiders ($r = 0.27$, $p < 0.001$). Knowledge of bats correlated with alternative conceptions about bats ($r = 0.24$, $p = 0.001$), but alternative conceptions of spiders failed to correlate with knowledge of spiders ($r = 0.09$, $p = 0.19$). Interestingly, however, bat knowledge correlated with spider knowledge ($r = 0.3$, $p < 0.001$) which suggests that there exist a poor relationship between spider myths and knowledge and that this is not a result of an inappropriate research tool.

Alternative conceptions about bats showed significant correlation with negativistic attitudes toward bats ($r = 0.16$) and spiders ($r = 0.15$) (both $p < 0.05$, respectively) (Hypothesis 5). Similarly, alternative

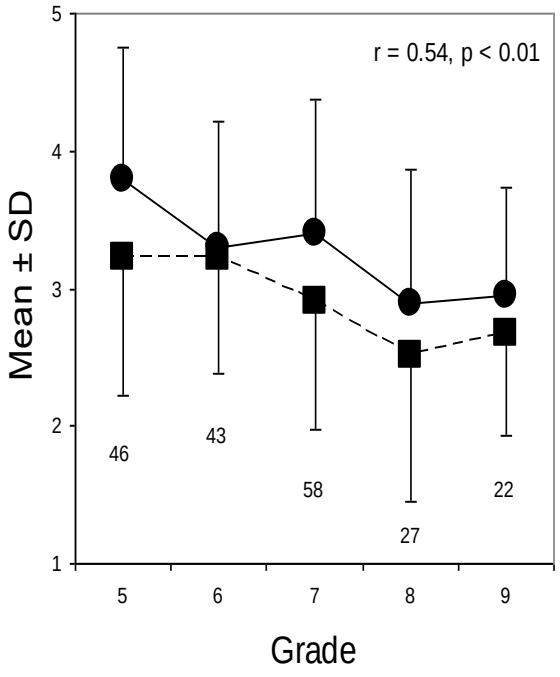

Figure 2. Ecoscientistic attitudes toward bats (circles) and spiders (squares). Pearson correlation coefficient calculated for attitudes toward bat and spider is shown. Numbers below means are sample sizes.

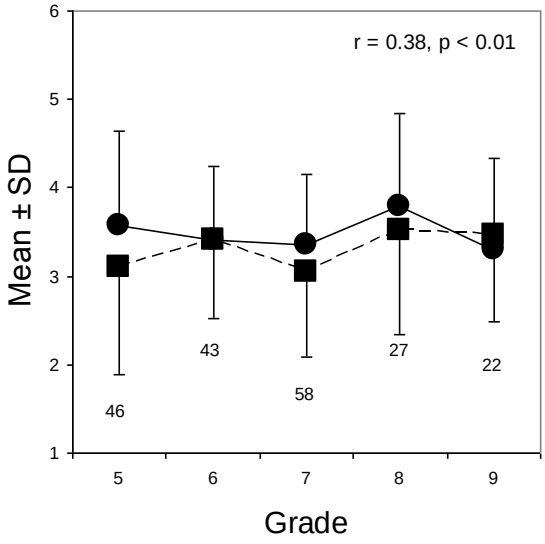

Figure 3. Negativistic attitudes toward bats (circles) and spiders (squares). Pearson correlation coefficient calculated for attitudes toward bat and spider is shown. Numbers below means are sample sizes.

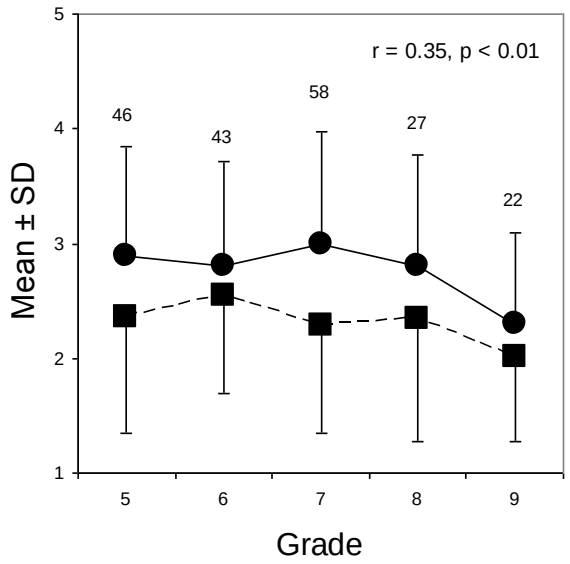

Figure 4. *Naturalistic attitudes toward bats (circles) and spiders (squares). Pearson correlation coefficient calculated for attitudes toward bat and spider is shown. Numbers above means are sample sizes.*

conceptions about spiders showed significant correlation with negativistic attitudes toward spiders (r = 0.24) and bats (r = 0.19) (p = 0.001 and 0.006).

Knowledge of bats correlated with negativistic (r = 0.33) and naturalistic attitudes (r = 0.21) toward bats (p < .001 and .003, respectively). Knowledge of spiders, however, showed only a correlation with negativistic attitudes toward bats (r = 0.22, p = 0.002). No other correlations were found.

DISCUSSION

The results of our study suggest that primary school children in Slovakia show more negative attitudes toward spiders in comparison with bats. Low attitude score was found especially in naturalistic attitudes which indicate that a substantial number of children display fear from a direct experience with these animals in nature. As expected, boys showed more positive attitudes toward bats and spiders than did girls. Both naturalistic and ecoscientistic attitudes decrease as the age of children increase, but this was not true for the negativistic attitudes which remained rather unchanged. Surprisingly, we failed to find a relationship between age and knowledge score. In line with our hypothesis, the distribution of alternative conceptions was irrespective of children's age. We also found a moderate correlation between attitude toward and knowledge of bats, but no similar tendency was found in spiders. The relationship between alternative conceptions and negativistic attitudes toward spiders and bats was also supported.

The general difference between attitudes toward bats and spiders can be explained by the origin of attitudes. Millar and Millar (1996) found that attitudes formed through direct experience with an 'attitude' object tend to be affectively based whereas attitudes that are formed on indirect experience such as being told seem to be cognitively based. Although we did not ask children for their experience with bats or spiders, it is clear that there is a very low likelihood of their having had a direct experience with bats in comparison with having had one with spiders, at least in Slovakia. Bats in Slovakia do not serve as food or pests, thus they are rather unfamiliar for the majority of people. Spiders are common in homes, gardens or in the field, thus first hand-on experiences can not be therefore ruled out. On the other hand, however, no spiders which can cause a serious injury occur in Slovakia. Moreover, surveys on children's pets-keeping activities showed that keeping spiders is rather occasional (Kidd and Kidd, 1985; Prokop, Prokop, and Tunnicliffe, 2008), so direct experiences with spiders are also questionable.

Slovakian children showed lowest and most negative attitude score in the Naturalistic dimension. This suggests that these children would rather avoid encountering bats and especially spiders in nature if they had the option so to do. This result implies that measuring only ecosientistic or negativistic dimension would lead in less accurate results. From the science education perspective, field trips (Orion & Hofstein, 1994), visits in museums and zoos (Tunnicliffe, Lucas, and Osborne, 1997; Lindemann-Matthies and Kamer, 2006) or other forms of non-formal or informal learning should be applied to increase children's knowledge, interest and motivation to learn (Eshach, 2007). Žoldošová and Prokop (2006) for example showed that lasting field trips about five day resulted in increased interest from elementary school children (10 – 14 year) toward cannibalism in the animal kingdom. The control group, who had not experienced a field trip, showed significantly lower interest toward cannibalistic topics. Moreover, although boys from the control group were more interested in cannibalism than girls before the field trip, after experiencing a field trip gender differences disappeared. This result emerged probably because Žoldošová and Prokop's field trip activities were also subjected to various activities and discussions about spiders which are well-known cannibals (Schneider and Elgar, 2004).

Gender differences found in our study clearly support male preferences for less popular animal species (Davey, 1994; Bjerke and Østdahl, 2004) and carnivore predators (Røskaft et al., 2003). It was found that males like invertebrates and bats more than females (Bjerke and Østdahl, 2004). Females, in contrast, show less interest to wild animals than males, but rear pets more frequently than males (Prokop Prokop, and Tunnicliffe,

2008). These facts imply that interest in less popular animals should be encouraged by school teachers and apparent care should be dedicated especially in girls. Keeping pets may have important effect on children's self-esteem, social skills and empathy (e.g. Poresky and Hendrix, 1990; Paul and Serpell, 1996). Girls' interest for keeping pets like spiders can be enhanced through girls' greater preference for biology (e.g. Jones, Howe, and Rua, 2000).

We propose that designing school biology projects particularly focused on less popular animals may contribute to a positive attitude development of elementary school children towards such animals. This would be especially beneficial in older children, in which attitude toward animals decrease (Kellert, 1996, Roskaft et al., 2003; Bjerke and Østdahl, 2004; this study). However, this area of preferences requires more attention of researchers.

Alternative conceptions about bats and spiders showed a significant relationship with children's negativistic attitudes toward these animals. Bats and spiders are especially good candidates for testing such relationships, because bats are commonly considered as birds and spiders are regarded as insects (Trowbridge and Mintzes, 1985, 1988; Strommen, 1995; Prokop, Kubiatko, and Fančovičová, 2007). Moreover, both spiders and bats as phobic animals (Davey et al., 1998) are commonly presented in horror films of which "realism" of images may contribute to perception of these images as realistic even though they are not actually real (Frank, 2003).

The higher the level of people's alternative conceptions, the more negative attitudes toward bats and spiders are therefore expected. This point is of special importance considering a correlation between attitude and behaviour (Hines, Hungerford, and Tomera, 1986/87). In other words, mystical beliefs of bats and spiders can result in negativistic behaviour toward these and other less popular animals. Both science teachers and researchers are therefore encouraged to investigate what ways can eliminate children's alternative conceptions about animals. Problem – based learning (Barrows and Tamblyn, 1980), participation in inquiry activities which involve making predictions, gathering data and their analyses and communicating findings (e.g. Chin and Chia, 2005) may greatly improve children's understandings of scientific phenomena.

Our data show that there is correlation between attitude and knowledge only in case of bats, but not in case of spiders. These results can be partly camouflaged by greater fear of spiders relative to fear of bats (this study) and/or by not well developed concepts about spiders. The Knowledge dimension however failed to show any correlation with age which suggests that development of basic concepts of bats and spiders is not in line with Slovak biology curriculum (Prokop, Prokop, Tunnicliffe, and Diran, 2007), because 10/11 years old children should be aware about basic facts of biology of bats and spiders. It would be nice to see how animal popularity (i.e. affective domain) does influence cognitive processes about these animals in more detail. Because both of the two animal examples investigated in our study were similarly less popular and, no further research instrument for examining children's concept structure was used (e.g. concept maps), we cannot be sure whether poor conceptual development about bats and spiders can be generally applied to other animals. We address this question for future research.

REFERENCES

Abell, S. K. (2000). From professor to colleague: Creating a professional identity as collaborator in elementary science. *Journal of Research in Science Teaching, 37*(6), 548-562.

Airas, M. Echolocation in bats. Unpublished paper available atwww.acoustics.hut.fi/u/mairas/pubs/echolocation_in_bats.pdf

Alsop, S., & Watts, M. (2003). Science education and affect. *International Journal of Science Education, 25*(9), 1043–1047.

Barrows, H. S., & Tamblyn, R. S. (1980). Problem-based learning: An approach to medical education.Berlin Heidelberg New York: Springer.

Bjerke, T., & Østdahl, T. (2004). Animal-related attitudes and activities in an urban population. *Anthrozöos, 17*(2), 109–129.

Bjerke, T., Østdahl, T., & Kleiven, J. (2003). Attitudes and activities related to urban wildlife: Pet owners and non-owners. *Anthrozöos, 16*(3), 252–262.

Brossard, D., Lewenstein, B., & Bonney, R. (2005). Scientific knowledge and attitude change: The impact of a citizen science project. *International Journal of Science Education, 27*(9), 1099–1121.

Chin, C., & Chia, L. G. (2005). Problem-based learning: Using ill-structured problems in biology project works. *Science Education, 89*(1), 1–24.

Cohen, M. R. (1973). Environmental information versus environmental attitudes. *Journal of Environmental Education, 5*(2), 5–8.

Davey, G. C. L. (1992). Characteristics of individuals with fear of spiders. *Anxiety Research, 4*, 299–314.

Davey, G. C. L. (1994). The "disgusting" spider: The role of disease and illness in the perpetuation of fear of spiders. *Society & Animals, 3*(1), 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., Reimann, L. (1998). A cross - national study of animal fears. *Behaviour Research and Therapy, 36*(7-8), 735-750.

Dhindsa, H. S., & Chung, G. (2003). Attitudes and achievement of Bruneian science students. *International Journal of Science Education, 25*(8), 907–922.

DiEnno, C. M., & Hilton, S. C. (2005). High school students' knowledge, attitudes, and levels of enjoyment of an

environmental education unit on nonnative plants. *Journal of Environmental Education, 37*(1), 13–25.

Eagly, A. H., & Chaiken, S. (1993). The psychology of attitudes. Fort Worth, TX: Harcourt Brace Jovanovich.

Eshach, H. (2007). Bringing in-school and out of school learning: Formal, non-formal and informal education. *Journal of Science Education and Technology. 16*(2), 171-190

Frank, S. (2003). Reel reality: Science consultants in hollywood. *Science as Culture, 12*(4): 427–443.

Haladyna, T., & Shauhnessy, J. (1982), Attitudes toward science: A review. *Science Education, 66*(4), 547–563.

Hines, J., Hungerford H. R., & Tomera A. N. (1986/87). Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. *Journal of Environmental Education, 18*(2), 1-8.

Hsu, S. J., & Roth, R. E. (1996). An assessment of environmental knowledge and attitudes held by community leaders in the Hualien area of Taiwan. *Journal of Environmental Education, 28*(1), 24-31.

Iozzi, L. A. (1989). What research says to the educator: Part one, environmental education and the affective domain. *Journal of Environmental Education, 20*(3), 3-9.

Jones, M.G., Howe, A., & Rua, M. J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science Education, 84*(2), 180–192.

Kaiser, F. G., Wolfing, S. & Fuhrer, U. (1999). Environmental attitude and ecological behaviour. *Journal of Environmental Psychology, 19*(1), 1–19.

Kellert, S. R. (1985). Attitudes toward animals: Age-related development among children. *Journal of Environmental Education, 16*(3), 29–39.

Kellert, S. R. (1993). Values and perceptions of invertebrates. *Conservation Biology, 7*(4), 845–855.

Kellert, S. R. (1996) *The Value of Life: Biological Diversity and Human Society*. Washington, DC: Island Press.

Kellert, S. R. & Westervelt, M. O. (1984). Children's attitudes, knowledge and behaviors towards animals. *Children's Environments Quarterly, 1*, 8–11.

Kidd, A. H., & Kidd, R. M. (1985). Children's attitudes toward their pets. *Psychological Reports, 57*(1), 15–31.

Kindt, M., Brosschot J.F., & Murit, P. (1996). Spider phobia questionnaire for children (SPQ-C): A psychometric study and normative data. *Behaviour Research and Therapy, 34*(3), 277–282.

Kraus, S. J. (1995) Attitudes and the prediction of behaviour: a meta-analysis of the empirical literature. *Personality and Social Psychology Bulletin, 21*(1), 58–75.

Kuhlemeier, H., Van Den Bergh, H., & Lagerweij, N. (1999). Environmental knowledge, attitudes and behavior in Dutch secondary education. *Journal of Environmental Education, 30*(2), 4–15.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology, 140*, 1–55.

Lindemann-Matthies, P., & Kamer, T. (2006). The influence of an interactive educational approach on visitors' learning in a Swiss Zoo. *Science Education, 90*(2), 296–315.

Lukas, K. E., & Ross, S. R. (2005). Zoo visitor knowledge and attitudes toward gorillas and chimpanzees. *Journal of Environmental Education, 36*(4), 33–48.

Makki, M. H., Abd-El-Khalick, F., & Boujaoude, S. (2003). Lebanese secondary school students' environmental knowledge and attitudes. *Environmental Education Research, 9*(1), 21–33.

Mangas, V. J. & Martinez, P. (1997). Analysis of environmental concepts and attitudes among biology degree students. *Journal of Environmental Education, 29*(1), 28–34.

Millar, M. G. & Millar, K.U. (1996). The effects of direct and indirect experience on affective and cognitive responses and the attitude-behavior relation. *Journal of Experimental Social Psychology, 32*(6), 561–579.

Mintzes, J. J., & Wandersee, J. H. (1998). Research in science teaching and learning: A human constructivistic view. In: Mintzes, J. J., Wandersee, J. H., & Novak, J. D. (Eds.). (1998). *Teaching science for understanding*. Orlando, FL: Academic Press.

Nunnaly, J. (1978). *Psychometric theory*. New York: McGraw-Hill.

Oppenheim, A. N. (1993). *Questionnaire design, interviewing and attitude measurement*. London: Pinter.

Orion, N., & Hofstein, A. (1994). Factors that influence learning during a scientific field trip in a natural environment. *Journal of Research in Science Teaching, 31*(10), 1097–1119.

Palaigeorgiou, G. E., Siozos P. D., Konstantakis N. I., & Tsoukalas I. A. (2005). A computer attitude scale for computer science freshmen and its educational implications. *Journal of Computer Assisted Learning, 21*(5), 330–342.

Paul, E. S., & Serpell, J. A. (1996). Obtaining a new pet dog: Effects on middle school children and their families. *Applied Animal Behaviour Science, 47*(1–2), 17–29.

Petty, R. (1995). Attitude change. In A. Tesser (Ed.), *Advanced social psychology*. New York: McGraw-Hill.

Pooley, J. A. (2000). Environmental Education and attitudes: Emotions and Beliefs are what is needed. *Environment and Behavior, 32*(5), 711–723.

Poresky, R. H., & Hendrix, C. (1990). Differential effects of pet presence and pet bonding in young children. *Psychological Reports, 67*(1), 51–54.

Prokop, P., Kubiatko, M., & Fančovičová, J. (2007). Why do cocks crow? Children's concepts about birds. *Research in Science Education, 37*(4), 393–405.

Prokop, P., Prokop, M., & Tunnicliffe, S. D. (2008). Effects of keeping animals as pets on children's concepts of vertebrates and invertebrates. *International Journal of Science Education, 30*(4), 431–449.

Prokop, P., Prokop, M., Tunnicliffe, S.D., & Diran, C. (2007). Children's ideas of animals' internal structures. *Journal of Biological Education, 41*(2), 62–67.

Reid, N. (2006). Thoughts on attitude measurement. *Research in Science & Technological Education, 24*(1), 3–27.

Røskaft, E., Bjerke, T., Kaltenborn, B. P., Linnell, J. D. C., & Andersen, R. (2003). Patterns of self-reported fear towards large carnivores among the Norwegian public. *Evolution and Human Behavior, 24*(3), 184–198.

Roth, C.E. (1992). *Environmental Literacy: Its Roots, Evolution, and Directions in the 1990's*. Columbus, OH: ERIC/CSM Environmental Education.

Salta, K., & Tzougraki, C. (2004). Attitudes toward chemistry among 11th grade students in high schools in Greece. *Science Education, 88*(4) 535–547.

Schneider J. M., & Elgar, M. A. (2004) Evolutionary significance of sexual cannibalism. *Advances in the Study of Behavior, 34*,135–163

Seligman M. E. P. (1971). Phobias and preparedness. *Behavior Therapy, 2*, 307-320.

Simpson, R. D., Koballa, T. R., Oliver, J. S., & Crawley, F. E. (1994). Research on the affective dimensions of science learning (p. 211-234). In D. Gabel (Ed.), *Handbook of research on science teaching and learning*. New York: Macmillan.

Strohm, B. (1982). Most facts about bats are myths. *National Wildlife, 20*(5), 35–39.

Strommen, E. (1995). Lions and tigers and bears, oh my! Children's conceptions on forests and their inhabitants. *Journal of Research in Science Teaching, 32*(7), 683–689.

Thompson, T. L., & Mintzes, J. J. (2002). Cognitive structure and the affective domain: on knowing and feeling in biology. *International Journal of Science Education, 24*(6), 645-660.

Trowbridge, J. E., & Mintzes, J. (1985). Students' alternative conceptions of animals and animal classification. *School Science and Mathematics, 85*(4), 304–316.

Trowbridge, J. E., & Mintzes, J. (1988). Alternative conceptions in animal classification: A cross-age study. *Journal of Research in Science Teaching, 25*(7), 547–571.

Tunnicliffe, S. D., Lucas, A. M., & Osborne, J. (1997). School visits to zoos and museums: A missed educational opportunity? *International Journal of Science Education 19*(9), 1039– 1056.

Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32*(4), 387–398.

Wilson, E. O. (1987). The little things that run the world (the importance and conservation of invertebrates). *Conservation Biology, 1*(4), 344–346.

Zimmerman, L. K. (1996). The development of an environmental values short form. *Journal of Environmental Education, 28*(1), 32–37.

Žoldošová, K., & Prokop, P. (2006). Education in the field influences children's ideas and interest toward science. *Journal of Science Education and Technology, 15*(3), 304–313.

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Appendix A. The Bat Attitude Questionnaire (BAQ) and the Spider Attitude Questionnaire (SAQ). The questionnaires were administered in the Slovakian children's first language and translated here for readers. Children were requested to respond to the following statements on a Likert five point scale. Negative items were scored in reverse order. Other items focused on children's alternative conceptions and knowledge are described in Results.

Ecoscientistic	Positive (P) or negative (N) meaning
I would like to read a book about bats/spiders	P
Greater attention should be dedicated to bat/spider protection	P
I would like to know more about bat movement in the night / I would like to know more about orb-weaving behaviour of spiders	P
I would like to watch on bats during night using a binocular with night vision / I would like to watch on a spider during web construction in the night	P
I would like to know more about large species of tropical bats/spiders	P
I like watching natural history films about bats/spiders	P
Capturing bats in the night would be an exciting story/Capturing spider would be an exciting story	P
Bats/spiders would be quite interesting animals	P
We should learn more about bats/spiders in the school	P
I would like to know how scientists investigate bats/spiders	P
I would like to participate on expedition which investigate bats/spiders	P
I feel equal to catch a bat/spider only with gloves on my hands	N
Negativistic	
When there is a bat around my window, I am unable to sleep/When there is a spider making a web on my window, I am unable to sleep	N
Even a though of touching a bat/spider scares me	N
If somebody teels me that bats/spiders are somewhere around me, I get nervous	N
I would never go to church tower if I know that bats/spiders are there	N
If I see a bat/spider, I feel tense	N
Bats/spiders scare me more than other animals	N
It makes me feel sick when I imagine a bat/spider	N
I would rather avoid to go to loft of my house if bats/spiders are present there	N
If I happened to find a bat/spider in my cellar, I would probably run away	N
Naturalistic	
I would like to camp near the ruin of old castle where bats occur / I would like to camp near the river where bats occur	P
Bats/spiders are sympathetic animals	P
I would like to catch a bat/spider in my hands	P
I would like to have some bats/spiders in the loft/cellar of my home	P
People should hang a special boxes for bats to attract bats to large cities/People should use fewer chemical agents in order to allow spiders living in human vicinity	P