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Abstract

Spiders are traditionally considered to be among the least popular of animals. Current evidence suggests that a negative attitude towards spiders could be influenced by both cultural and evolutionary pressures. Some researchers suggest that science education activities could positively influence students' perceptions of spiders. Their evidence is, however, ambivalent. Using a five-point score Likert-type questionnaire in which the items were developed in a similar way to four of Keller's categories of attitude (scientistic, negativistic, naturalistic, and ecologistic) towards invertebrates, we compared the level of knowledge of and attitudes towards spiders of high school students from two countries, Slovakia (n = 354) and South Africa (n = 382). The students represented different cultures and followed dissimilar science education curricula. Only among the Slovakian students there was a statistically significant, but low correlation between knowledge and attitude (r = .30). The Slovakian students had less fear of spiders. The South African students scored higher in the categories of scientistic, naturalistic and ecologistic attitudes. Comparison of attitude towards spiders of indigenous Africans from coeducational Catholic schools revealed that, South African students have greater fear of spiders than Slovakian students, supporting the biological preparedness hypothesis. This hypothesis predicts a greater fear of spiders in South Africa than in Europe since several South African spiders possess venoms that are dangerous to humans. The results of this study are discussed from science education, cultural and evolutionary perspectives.

Introduction

Human attitudes towards and fear of animals are determined by cultural and evolutionary factors (Herzog & Burghardt 1988, Fredrikson, Annas, & Wik, 1997; Davey et al., 1998). In the school age group of 6 – 16 years children's attitudes develop through affective, cognitive and ecological stages (Kellert, 1985; Field & Davey, 2001). Considering that the main attributes of scientific literacy include the development of both knowledge (especially conceptual and procedural) and attitudes (Jenkins, 1990), it is important to influence students' attitudes positively towards animals. The more they know about animals and their environment the better they will be able to help save the earth's biodiversity.

Humankind is mainly attracted to large mammals like dolphins (Barney, Mintzes, & Yen, 2005), pandas (Bexell et al., 2007) and elephants (Swanagan, 2000). The relationship between humans and less popular animals like large carnivores (Røskaft et al., 2003), and sharks (Thompson & Mintzes, 2002) is, however, still poorly understood.

Even less is known about human attitudes towards invertebrates. Both adults and children tend to avoid invertebrates because they are behaviourally and morphologically unfamiliar (Wilson, 1987; Kellert, 1993). This is surprising since this group of animals has become of increasing value in the pharmaceutical industry (Nicholson & Graudins, 2002) and in agriculture (Nyffeler, Dean, & Sterling, 1987; Kellert, 1993). The appearance of invertebrates in ecological programmes on television often evokes anxiety in viewers. This anxiety correlates negatively with people's attitudes towards invertebrates and thus with their level of interest to know more about them (Randler, Ilg, & Kern, 2005). Invertebrates are easy to observe and handle and could provide good subjects for the study of different types of life-cycles. However, the use of these animals has been little explored in science classes.

Attitudes towards spiders

Spider phobia is one of most common animal phobias in Western society (Kirkpatrick, 1984; Fredrikson et al., 1996; Muris, Merckelbach, & Collaris 1997). This fear is attributed either to genetic, social and cultural differences, or personal experiences (Fredrikson et al., 1997). Seligman (1970, 1971) first introduced a hypothesis of biological preparedness to explain why people dislike spiders and snakes more than other animals. Seligman (1970) proposes that these animals presented a critical danger to our ancestors, hence predisposing them to rapid learning processes. For example, quick reactions to snake-induced stimuli were evolutionarily selected for (Öhman, Carlsson, Lundqvist, & Ingvar, 2007).

Davey (1994) and Davey et al. (1998), however, argue that fear of spiders has a cultural rather than evolutionary background. They found that fear of spiders covaries with disgust-sensitivity. This means that spiders are viewed in the same category as cockroaches, snails, wasps and other, non-predatory, but "disgusting" animals (Davey et al., 1998). Although the link between spiders and disgusting animals is puzzling at first glance, they propose that spiders in the Middle Ages were associated with illness, e.g. the plague (Davey, 1994). Spiders, then, were seen as harbingers of plague and death. Davey (1994) mentions that, according to Renner (1990), this association was used as the basis for Jeremias Gotthelf's famous story "The Black Spider", published in 1842. Although Davey's (1994) 'disease avoidance' hypothesis still has to be supported, he predicts that Europeans should be more fearful of spiders than, for example, some African tribes. In the same study Davey (1994) again cites Renner (1990) who mentions that in some African cultures the spider is revered as a wise creature and its nests are cleaned and protected by the local people. He expects that some African cultures will have a more positive attitude towards spiders than European cultures. In a later study Davey et al. (1998) conducted a cross-cultural comparison of animal fears, including fear of spiders. A sample from Africa was, however, not included.

On the other hand, the 'biological preparedness' hypothesis (Seligman, 1970) could predict a greater fear of spiders in South Africa than in Europe since several South African spiders possess venoms that are dangerous to humans (e.g. Dippenaar-Schoeman and Jocqué, 1997; Vetter & Visscher, 1998). In Europe there are no such venomous spiders.

Although children are excellent models for testing both evolutionary predispositions to avoid unpopular animals like spiders, and the effects of education strategies which would help to eliminate fear of spiders, systematic spider attitude surveys among school age children are rare. As far as we are aware, only Prokop and Tunnicliffe (2008) have examined attitudes towards spiders in three attitude dimensions (ecoscientistic, negativistic and naturalistic) as well as knowledge of these animals and myths about them. Their sample comprised 196 children aged 10 – 16 years. Other research on school children has been mainly focused on fears and phobias (Muris, Merckelbach, & Collaris 1997). Prokop and Tunnicliffe (2008) found that children's attitudes towards spiders were rather negative (although less negative in boys than in girls), and the mean attitude score decreased as their age increased. Importantly, a substantial number of children believe in myths about spiders. For example, only one third (28 %) of all children in their research was aware that the bite of the tarantula is not fatal to humans. Again, a majority of children (62 %) incorrectly believed, or were undecided about, the myth spiders are dangerous to humankind particularly when they are asleep. Belief in these stories correlated with the negativistic dimension, meaning that the stronger the belief the higher the score of negative attitudes towards spiders. Their research suggests that children's views of spiders need to be improved.

Gender differences in attitudes towards spiders

A number of studies were conducted on participants of primary school age (Kindt, Brosschot, & Murit, 1996; Muris et al., 1997; Prokop & Tunnicliffe, 2008) and adolescents (Frederikson

et al., 1996; Gerdes, Uhl, & Alpers, 2009) report that males are less fearful of spiders than females. To date, however, very little is known about the origin of this gender difference. According to the ‘‘environment of evolutionary adaptedness’’ hypothesis (Hawkes, O’Connell, & Blurton Jones, 1991), men were hunters and therefore had to deal directly with many dangerous animals and engaged in greater risk-taking activities than females (Byrnes, Miller, & Schaffer, 1999). Women, on the other hand, probably stayed in the close vicinity of their camps because their parental duty was to raise and care for their children. Thus, women more easily developed fear towards animals that posed a threat (Røskaft et al., 2003).

Muris, Steerneman, Merckelbach, & Meesters (1996), posing the question why fear of spiders is more common among girls than among boys between 9 and 13 years, found that conditioning experiences play a most important role. Fredriksson et al. (1996) suggest that gender differences in animal phobias may reflect different genetic and/or social transmission patterns. The authors speculate that social transmission of fears and phobias is probably more frequent among women than men.

Žoldošová and Prokop (2006), researching the effect of a five-day field trip on cannibalism in spiders on primary school children (10 – 14 years), noticed that the fieldwork generated an increased interest in the topic among the participants. Before the field trip boys were more interested than girls in cannibalism, but gender differences disappeared after the experience. The researchers linked this to the discussions and practical activities with spiders during their field trip. The control group, who did not participate in the field trip, had significantly lower interest in the subject. Unfortunately, these authors failed to control for possible changes in fear of spiders.

Can science education improve attitudes towards spiders?

Environmentally literate citizens have a certain level of knowledge and relevant attitudes and display pro-environmental behaviour (Roth, 1992). Attitudes correlate with behaviour (Kraus, 1995), and several researchers found a link between attitude and knowledge (Cohen, 1973; Hsu & Roth, 1996; Kaiser, Wolfing, & Fuhrer, 1999; Thompson & Mintzes, 2002; Prokop, Kubiatko, & Fančovičová, 2008; Prokop, Fančovičová, & Kubiatko, 2009). Considering these arguments with the historically greatly emphasised link between science education and the learning capacity of students (Alsop & Watts, 2003), one expected that acquiring knowledge or developing a greater awareness of one's environment would result in positive changes in attitude (Morgan & Gramann, 1989; Kellert, 1993). However, conflicting results in several studies do not support the link between attitude and knowledge. For example, Brossard, Lewenstein and Bonney (2005) investigated the effects of an informal science education project (The Birdhouse Network) on the participants' knowledge of birds, and their attitudes towards science and the environment. They found that participants' knowledge of birds increased in terms of basic facts about the biology of birds. However, they did not find any statistically significant change in participants' attitudes towards science and the environment. Similarly, Kuhlemeier, Van Den Bergh, and Lagerweij (1999) and Makki, Abd-El-Khalick, and Boujaoude (2003) found only moderate correlations between knowledge of and attitude towards the environment.

In the same sample of participants Prokop and Tunnicliffe (2008) found a significant correlation between knowledge of and attitudes towards bats, but not towards spiders. These authors hypothesize that a weak link between these qualities could be expected when there was a conflict between self-awareness and the evolutionary predisposition to avoid a particular animal. Their findings support the hypothesis, as the self-perceived danger was lower for bats (where the correlation was found) than for spiders.

In a recent study Muris, Mayer, Huijding and Konings (2008) investigated whether disgust-related information has an impact on the fear beliefs about Australian marsupials (unknown to the research sample) in children aged 9 – 13 years. Their results indicate that disgust-related information did not only produce higher levels of disgust but also increased the children's fear beliefs about these animals. Conversely, cleanliness-related information decreased levels of disgust and yielded lower levels of fear.

These findings suggest that knowledge about certain animals could improve attitudes towards them. However, less popular animals that are as important in nature as the more popular ones are perceived somewhat differently and require a more educated approach (Prokop & Tunnicliffe, submitted). For example, Morgan and Gramann (1989) reported that increased knowledge of snakes (controversial animals) alone failed to improve children's attitudes towards them. However, when children experienced physical contact with snakes, as well as an informal presentation about the biology of snakes, their attitudes changed positively. Similarly, Žoldošová and Prokop (2006) found that actual observations of sexual cannibalism in spiders during informal field trips increased children's interest in that behaviour.

Science education in South Africa and Slovakia

Slovakia and South Africa are geographically, ethnically and culturally very distinct countries. Not surprisingly, science education approaches in these countries, at least in elementary schools and high schools, are different. Thus, in the next section, we provide a brief overview of the main differences in science education strategies.

In South Africa the central government provides a national framework for school policy, but administrative responsibility lies with the provinces. Power is further devolved to grass-roots level via elected school governing bodies, which have a significant say in the running of their

schools. The National Department of Education is responsible for education across the country as a whole, while each of the nine provinces has its own education department. South Africa's National Qualifications Framework (NQF) recognises three broad levels of Education and Training: General, Further and Higher.

General Education and Training runs from Grade 0 through to Grade 12, the year of matriculation. Education is compulsory, but not free, for all South Africans from age 6 (Grade 1) to 15 or the completion of Grade 9, which earns a General Education and Training Certificate. To enter university students have to pass their matriculation at a certain level, measured in points.

Education in Slovakia consists of a free education system based on 9 years of compulsory school attendance and follows the Standard National Curriculum. Pupils are admitted to Grade 1 at the age of 6.

After completing primary school, students are required to apply for admission to a secondary school. The secondary education is currently in three streams: gymnasia, technical secondary schools and vocational secondary schools. These schools are established by self-governing regions after approval by the respective central body of the state administration and by social partners. Churches, legal entities and private persons may also establish schools. After secondary education students can continue their studies at university.

The main difference in the science education system in the two countries lies in the teaching curriculum. Biology teaching in South Africa is based on ecosystems, but the Slovakian system is based on systematic zoology and botany. In other words, South African students are taught about selected organisms typical of particular ecosystems; while Slovakian students are taught about many organisms following botanical or zoological systems without acquiring a deeper knowledge of which organisms inhabit different ecosystems. In summary, it would be expected that Slovakian children have greater factual knowledge of animals, but it is

questionable whether they are able to apply this knowledge to organisms in natural ecosystems. South African students are expected to understand more about ecological relationships of biotic and abiotic factors in nature. Besides cultural differences between South Africa and Slovakia, the educational system seems to be a significant factor that can potentially influence attitudes towards animals.

Purpose

This study examines cross-cultural differences in students' attitudes towards spiders. We compare two culturally distinct countries, South Africa and Slovakia (Europe), because the risk of being bitten by spiders is different in each country. There are about 6,000 spider species in Africa, and at least 2,000 in South Africa (Dippenaar-Schoeman & Jocqué, 1997), but only about 1,000 species in Slovakia (Gajdoš, Svatoň, & Sloboda, 1999). Several spiders in South Africa pose the risk of serious injury (e.g. the black and brown button spiders of genus *Latrodectus*, the violin spider (*Loxoseeles* sp.), the sac spider (*Cheiracanthium* sp.) and the six-eyed sand spider (*Sicarius* sp.) (Dippenaar-Schoeman & Jocqué, 1997; Vetter & Visscher, 1998). In contrast, there are no reports from Slovakia of spiders that are dangerous to humans. Our specific intention was to investigate whether living in countries with different risk levels of being bitten by spiders influences the students' attitudes towards them. Prokop and Tunnicliffe (2008) speculate that the risk of being threatened by animals should break the link between attitudes and knowledge. Living in an area with a higher risk of threat should be associated with low correlation between attitudes and knowledge. Our aim is to understand the links between attitude and knowledge. This could provide useful information for science education as it is not yet known whether teaching strategies should consider taking this risk factor into account. Again, because former research was focused mainly on spider phobia, it is

not known whether spider avoidance (negativistic attitude) also influences students' views on the role of spiders in nature (ecologistic attitudes).

This paper explores the following questions: (1) Is there any difference in knowledge of and attitude towards spiders between Slovakian and South African high school students? (2) Are there any differences in attitude towards spiders with respect to gender? (3) Is there any link between attitude towards and knowledge of spiders among Slovakian and South African high school students?

High school students were chosen because students aged between 13 – 18 years appear to be the most appropriate targets to foster ethical and ecological understanding of the role of animals in nature (Kellert, 1985). It appears that the level of sensitivity for the environment in an adult is formed during the teenage years (Sivek, 2002). Therefore high school students represent the most appropriate age group for environmental education, because they are capable of understanding complex situations in the environment (DiEnno & Hilton, 2005).

Methods

Construction of the Spider Attitude Questionnaire (SAQ)

Students' attitudes towards and knowledge of spiders were measured by 5 – point Likert-type items adapted from a questionnaire published elsewhere (the Spider Attitude Questionnaire, Prokop & Tunnicliffe, 2008; Appendix A). Items were developed in a similar way to Kellert's (1996) attitude scale towards animals. Most of the negativistic items were derived and modified following the Spider Phobia Questionnaire (Kindt et al., 1996). Knowledge of spiders was measured by items that represent basic facts about their biology. Attitude items were prepared following questionnaires published in similar studies (e.g. Thompson &

Mintzes, 2002; Barney et al., 2005). The ***negativistic*** dimension is designed specifically to measure active avoidance of spiders as a result of dislike or fear. The ***scientistic*** dimension measures interest in the biology of spiders and the gathering of information about them. The ***ecologistic*** dimension investigates the participants' concern for the role of spiders in nature and the way in which humans and spiders interact. The ***naturalistic*** dimension gauges interest in direct contact with spiders and how one reacts when one encounters them in nature.

The original, self-constructed questionnaire consists of 24 attitude items and 10 knowledge items. They are scored from 1 (strongly disagree) to 5 (strongly agree). Items are formulated either negatively or positively (Oppenheim, 1999). Negative items are scored in the reverse order. Summed scores provide a composite index of attitude towards spiders. Low scores reflect relatively negative attitudes and high scores reflect positive attitudes. The highest attitude score was 120 and the highest knowledge score was 50. Similarly, mean scores below 3.0 reflect negative attitudes or poor knowledge, and scores above 3.0 reflect positive attitudes or good knowledge. If the overall mean score was about 3.0, attitudes were considered neutral.

Two professors of zoology from two different universities and two experts in biology education established the validity of the questionnaire through a review. They were asked whether the items in each dimension were relevant to the aim of the questionnaire. Revisions were based on their comments and suggestions.

The attitude scores (n = 24 items) are subsequently submitted to factor analysis (PCA with Varimax rotation) and four factors with eigenvalues greater than 1.0 derived. The four dimensions represented in the rotation matrix are: scientistic, negativistic, naturalistic, and ecologistic. These four factors explain 56 % of the total variance. According to Reckase (1979), the prime factor should explain at least 20 % of total variance and the difference between the second and third factor should be lower than the difference between the first and

second factor. In agreement with these suggestions, the scientistic dimension explained 36.6 % of total variance, the negativistic dimension explained 10.1 %, the naturalistic dimension 5.1%, and the ecologistic dimension 4.4 % of total variance.

Finally, we measured the reliability of all remaining items. The Cronbach's alpha coefficient for the whole instrument (0.92) indicates that the questionnaire is highly reliable (Nunnaly, 1978). In addition, the same reliability test (Nunnaly, 1978) applied to each separate dimension allows us to accept all dimensions. The inter-item correlations of attitude items ranged between 0.14 and 0.41.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (the index for comparing the magnitude of the observed correlation coefficients to that of the partial correlation coefficients) is 0.95, which allows us to apply factor analysis. Bartlett's test of sphericity is used to test the null hypothesis that variables in the population correlation matrix are uncorrelated. The observed significance level is high ($\chi^2 = 7820.57$, df = 276, $p < .001$). It is concluded that the strength of the relationship among variables was strong (George & Mallery, 2001). These indicators thus allowed us to use factor analysis for the data.

Participants

The study was conducted between September and October 2007. A total of 354 Caucasian high school students (222 females and 132 males) from four high schools in Slovakia and 382 high school students (324 females and 58 males) from four schools in South Africa participated in the study. Selection of participants was not intentional, but was based on teachers' willingness to administer questionnaires in selected schools. If the teacher agreed, the questionnaire was administered to all participants in selected classes irrespective of the participants' attitudes towards animals. The participants ranged from 14 - 17 years ($M = 15.02$,

SD = 0.81), their ages being not significantly different (*t*-test, *t* = 1.41, df = 734, *p* = .16). Because the male-female ratio was skewed in the sample from South Africa, the power of statistical difference between males and females was additionally analysed by calculating the effect size measure (Cohen's *d*) for groups (Cohen, 1988), because it is independent of sample size. The measure is calculated as the difference between two means, divided by the standard deviation of either group. Cohen (1988) offered the following guidelines for interpreting effect sizes: *d* = 0.20-small effect; *d* = 0.50-medium effect; *d* = 0.80-large effect. In common sense terms, a *d* of 0.20 may be statistically significant but the difference is not apparent to the casual observer, a *d* of 0.50 is noticeable to the average person, and a *d* of 0.80 or higher is quite obvious (Lippa, 2002).

The educational system in South Africa is still very much in transition. A new system was introduced after the democratic elections in 1994 and the levels of education in the participating schools are still very much coloured by the former apartheid-era school system. All schools in the new system should theoretically be mixed-race schools, but schools in traditionally black areas (urban as well as rural) are often attended only by children from black families. Schools from traditionally white areas have since 1994 accepted children from all other race groups. Many teachers of all races, but especially in the traditionally black schools, still struggle to apply the new curriculum. In these schools English, mathematics and science were often poorly taught or understood in the past, and this is still the case in many instances today either because teachers themselves do not know enough English or have an inadequate understanding of mathematics and science, or the foundation of these subjects among the children is poor.

The schools participating in the Spider Attitude Questionnaire (SAQ) were selected to represent the diversity of backgrounds of a population sample of the pre-1994 period.

The four schools participating in this project are all private Catholic schools. Two of these (John Martin Catholic School and St. Bede's) are co-educational (boys and girls), situated in relatively poor areas (urban and rural respectively) and attended only by children from black families. St. Ursula's is a girls-only, traditionally white-only school, but since 1994 it has admitted children from coloured and black families who belong to the middle income group. The ratio of coloured and black to white children is 50:50. Brescia House School, situated in an affluent area, is a single-sex school (girls-only) and traditionally white, but since 1994 it has also admitted children from black families (98% white, 2% black).

All four Slovakian schools were typical state high schools with enrolments of between 300 – 600 students. Two of them were also Catholic schools so that differences in the selection of samples between the two countries were minimised. The third was a grammar school and the fourth a health school. There are no obvious differences in socioeconomic status (because these schools are not private) or race (all students were Caucasian) between students in the participating schools in Slovakia.

Although we were originally interested in differences in attitude towards spiders among all participating schools, or at least between Catholic and government schools, these differences which are presented in Table 1 should be interpreted with extreme caution. This is because some South African schools were girls-only (single-sex) and all of them were Catholic. This strong gender bias does not allow us to compare Catholic vs. non-Catholic schools, because the results of such statistical analysis would be interpreted as differences between Catholic and single-sex schools, or South African and Slovakian, but not Catholic and non-Catholic schools. We therefore prefer comparisons based on gender and country in this research, rather than differences among schools, to avoid an inaccurate interpretation of data. For this purpose,

dependent variables (knowledge or attitudes) were controlled for the effect of age and school by calculating residuals from regression analysis.

All questionnaires were personally administered by the same researcher (A.T.) in both countries. Before administration South African teachers were consulted about the appropriateness of language of the SAQ and changes were made accordingly. In Slovakia, the wording of items and their appropriateness was maintained from previous research (Prokop & Tunnicliffe, 2008).

Results

Students' knowledge of spiders

A two – way ANOVA showed that there is a significant effect of country ($F_{1,732} = 9.03$, $p < .01$, $\eta^2 = .01$) on the students' knowledge of spiders, but gender differences remained non-significant ($F_{1,732} = 3.01$, $p = .08$, $\eta^2 = .004$). The interaction between country × gender was again not significant ($F_{1,732} = 1.88$, $p = .17$, $\eta^2 = .003$). The effect of country showed that Slovakian students had a better knowledge of spiders ($M = 33.73$, $SE = .23$) compared to the South African students ($M = 32.31$, $SE = .29$). However, the η^2 for the effect of country explains only 1.0 % of the total variance of the knowledge score which means that this difference is very insignificant. The effect of gender was much lower (see above). Cohen's d values for gender differences corroborate previous findings. To summarize, values obtained from calculating all combinations (males vs. females from two countries), showed that South African males tend to have a lower knowledge score than Slovakian males ($d = 0.49$) and females ($d = 0.54$) (medium size effects). Effect sizes for other combinations did not exceed a value of 0.22 (small effect).

Most students correctly identified the number of legs a spider has (70 % were correct). About a third (29 %) of all participants answered that sexual cannibalism is not widespread among

spiders. This myth is more frequently met among the South Africans (M = 2.80, SE = 0.08) than the Slovakians (M = 3.22, SE = 0.06) (t = 5.20, df = 734, p < .001). A third (35 %) scored that all spiders paralyse their prey with venom. Approximately the same percentage of students (37 %) believed that spiders are particularly dangerous at night when people are asleep. This myth, too, was more widely spread among the South African (M = 2.64, SE = .09) than the Slovakian students (M = 3.30, SE = .07) (t = 7.23, df = 734, p < .001). About a third (35 %) knew that spiders do not belong to the insects. Little is known about the feeding habits of spiders; only 40 % agreed that spiders usually catch smaller animals. There seems to be no knowledge of maternal care for spiderlings, since only 32 % knew that some female spiders carry their young on their backs. Interestingly, this was the only item that was answered significantly better by South African students (M = 3.34, SE = .06), than Slovakian students (M = 3.17, SE = .05) (t = -2.63, df = 734, p = .009). About the same percentage (37 %) knew that orb-weaving behaviour is genetically fixed. Slovakians answered this item better (M = 3.46, SE =.06) than the South Africans (M = 3.2, SE = .08) (t = 4.30, df = 734, p < .001). The best answered questions were those about the overwintering of spiders (55 %) and orb-web adhesiveness (69 %).

Attitudes to spiders

The histogram (Fig. 1) of the Likert scale shows that negative/neutral responses (scores 1 – 3) are more prevalent than positive responses (scores 4 and 5). This suggests that at least 30 % of all participants are afraid of spiders. Two-way multivariate analysis of variance (MANOVA) with gender and country as factors and residual values from four attitude dimensions as dependent variables was performed.

Insert Fig. 1 here

Attitudes to spiders are mainly influenced by gender (Wilk's $\lambda = 0.86$, $F_{4,729} = 29.82$, $p < .001$, $\eta^2 = 0.14$), followed by country (Wilk's $\lambda = .95$, $F_{4,729} = 10.02$, $p < .001$, $\eta^2 = .05$) and interaction between these variables (Wilk's $\lambda = .95$, $F_{4,729} = 8.91$, $p < .001$, $\eta^2 = .05$). The latter result refers only to the higher score of South African male and female students rather than to different gender-related patterns between countries.

In both countries, males score higher in the negative attitudes towards spiders in each dimension compared with females (Fig. 2). Univariate analysis of gender differences is significant at level $p < .001$. All Cohen's d values calculated for means derived from each dimension fully corroborate these differences. All d's ranged between 0.47 – 1.08 which means that these differences are of medium-large statistical power. This indicates that males generally have a more positive attitude towards spiders than females.

Insert Fig. 2 here

There is no significant difference between the scores of either country with regard to the negativistic dimension ($F_{1,732} = .61$, $p = .43$) which means that the South African students were not more fearful of spiders than the Slovakian students.

South African students scored higher in the naturalistic, scientistic and ecologistic dimensions ($F_{1,732} = 6.71$, 36.16 and 7.62, respectively, all $p < .01$ and less) meaning that they were more interested in the biology of spiders, and in direct contact with them and were aware of their importance in nature.

Although previous analyses were controlled for some potentially confounding factors, we performed additional analysis, to avoid misinterpretation of results. Only two Slovakian

Catholic schools (A. Merici and ESA) and two coeducational South African Catholic schools (John Martin Catholic School and St. Bede's) entered this analysis, because all of them are Catholic, attended only by indigenous Africans (South Africa) or white (Slovakia) males and females. Two-way MANOVA supported previous analysis: attitude towards spiders were influenced by country (Wilk's $\lambda = .71$, $F_{4,384} = 39.16$, $p < .001$, $\eta^2 = .29$) and gender (Wilk's $\lambda = .85$, $F_{4,384} = 16.52$, $p < .001$, $\eta^2 = .15$). Univariate results revealed similar differences between countries: South African children scored higher in the scientistic and ecologistic dimensions ($F_{1,387}$ =91.62 and 16.78, respectively, all $p < .001$), but there was no difference in naturalistic dimension ($F_{1,387}$ =0.25, $p = .64$). Interestingly, Slovakian children scored significantly higher in the negativistic dimension ($F_{1,387}$ =13.01, $p < .001$) which means that South African students are more fearful of spiders than the Slovakian students. Males scored always higher than females.

The scientistic dimension

Students scored higher than 50 % in only two of the seven items of the scientistic dimension, which means that spiders were not perceived very positively in this dimension. Little more than half of the students would like to know how scientists investigate spiders (55 %) and asked for more information about large tropical spiders (52 %). About 44 % wanted to know how spiders build their webs. About one-third is attracted to reading a book (39 %) or watching a natural history film (37 %) about spiders. The same percentage (30 %) would like either to participate in an expedition to investigate spiders or to learn more about spiders in school. In summary, spiders appear to be interesting animals for a significant number of students.

The negativistic dimension

About one-third of the children showed negative attitudes towards spiders. For example, 28 % agreed that even the thought of touching a spider scared them, or would not be able to sleep when there was a spider in the window (35 %). Nearly half of them (47 %) agreed that they become nervous when they know that a spider is somewhere close to them, or that they will run from a room which has a spider in it (41 %). A third (36 %) did not like pictures of spiders, while a similar number (32 %) claimed that spiders scared them more than other animals and that they did not want to catch a spider even if they were wearing gloves. This means that about one-third of children show a strong aversion to spiders.

The naturalistic dimension

Only 13 % of all students would be agreeable to camping near a river where spiders were found or would like to have spiders under their roof. The majority of students (69 %) preferred to live in a country with fewer spiders. A similar number of students (64 %) did not want to catch a spider with bare hands. About half (49 %) would not like to go to places where spiders were found and disagreed that capturing spiders was an exciting activity (56 %). In conclusion, the naturalistic dimension underscored the negative attitudes of students towards spiders. Most of the students did not want to be in physical contact with spiders.

The ecologistic dimension

Within this dimension the most positive attitude is reflected in the observation of web building behaviour (41 %). The protection of spiders (35 %), students' sympathies towards spiders (23 %) and reduction in the use of chemicals to increase a spider population in the vicinity of humans (22 %) were viewed positively by only a minority of students. This suggests that students have either limited information about the role of spiders in the

environment and/or they simply do not favour the protection of spiders because of their low popularity.

The relationship between knowledge of and attitudes towards spiders

In the subsequent analyses, dependent variables (knowledge or attitudes) were controlled for the effect of gender and school by calculating residuals from regression analysis. After comparing the attitude and knowledge scores of each country separately, there is a low, although statistically significant correlation between knowledge and attitudes in Slovakia, but very weak correlation in South Africa (Fig. 4, 5). To examine the relationship between attitudes towards and knowledge of spiders, multiple regression (forward stepwise method) was performed. In this analysis, four dimensions of students' attitudes towards spiders were chosen as predictor variables. Knowledge of spiders was defined as a dependent variable. In analysing the Slovakian sample, a significant model emerged ($F_{1,352} = 37.16$, $p < .001$, adjusted $R^2 = 0.10$). This model accounts for 10 % of the variance, and indicates dependency between the scientistic dimension and knowledge of spiders, because other variables were excluded from the model. A different situation was found in South Africa. Although a significant model emerged ($F_{1,380} = 12.75$, $p < .001$, adjusted $R^2 = 0.03$), it explains only 3 % of variance. This model represents an association between the ecologistic dimension and knowledge of spiders. Other predictors were excluded from the model. In summary, attitudes towards spiders in Slovakian students are partly influenced by scientistic attitudes. In contrast, South African students show a weak association between attitudes and knowledge and the knowledge score is partially associated with their ecologistic attitudes.

Insert Figs 3 and 4 here

Discussion

This study compares the attitudes of high school students towards and knowledge of spiders in South Africa and Slovakia.

The distribution of the overall mean scores suggests that these attitudes are generally rather neutral/negative. Compared with males, female students generally score lower in all four dimensions. Correlation between knowledge of and attitudes towards spiders is generally low, but this association is stronger among Slovakian than South African students. Knowledge of spiders shows the highest correlation with scientistic attitudes in Slovakian students, and with ecologistic attitudes in South African students. South African students have a similar level of fear of spiders as Slovakian students, but they score higher in the scientistic, naturalistic and ecologistic attitudes.

Effect of culture, evolution or science education strategies?

Our results reveal significant differences in attitude towards spiders among high school students in the two countries, which might be linked to cultural rather than evolutionary origins. South Africa and Slovakia also have different science education strategies. For this reason it is possible that the differences in attitude are the products of both cultural background and science education. However, our results do not allow us to draw any conclusions with regard to this issue. We would therefore rather discuss how these three mechanisms, evolutionary differences, cultural background, and education have an impact on the students' attitudes.

How can evolutionary or cultural differences account for these dissimilarities in attitudes towards spiders? Our results do not support the 'disease avoidance' hypothesis which postulates that because of historical events (Great Plagues in the Middle Ages, Davey, 1994), fear of spiders is greater among Europeans than people of African descent. This is in

agreement with recent research by Gerdes et al. (2009) who also did not support the 'disease avoidance' hypothesis in their comparison of human fear of spiders and other arthropods. The same hypothesis does not explain why Slovakian students are less interested in the biology of spiders (the scientistic dimension), the role of spiders in nature (the ecologistic dimension), and direct contact with spiders (naturalistic dimension). Compared to Slovakian students South African students have closer contact with nature which might account for their more positive attitude towards spiders. However, more conservative comparison of Catholic schools revealed that South African students have greater fear of spiders than Slovakian students. Considering that the sample of participants in this analysis consisted from only indigenous Africans, these results suggest that South African peoples have greater fear of spiders than Slovakian peoples supporting the biological preparedness hypothesis (Seligman, 1971). Further research in this area is needed.

The revised national curriculum for science education in South Africa does not prescribe that students are required to learn anything about spiders and is not as restrictive as the Slovakian curriculum. In South Africa students learn about the biology of animals and their differences. South African teachers have more opportunities to choose between topics that they consider of interest and value to their students. It is therefore possible that South African teaching strategies are more supportive of student's interest in animals than the corresponding Slovakian strategies. This could explain why the level of knowledge of spiders in South African students has no bearing on their interest in the animals (Fig. 4). In contrast, Slovakian teachers have to adhere rigorously to strict teaching plans. Slovakian children first learn to compare spiders with insects. Later they learn systematic zoology where the emphasis is on exact knowledge of spiders.

Significance of gender

As in several other studies (e.g., Gerdes et al., 2009), we found that fear of spiders is greater in females than in males. Compared with males, females scored lower in all four attitude dimensions. This suggests that males have not only less fear of spiders, but also a greater interest in them. It is questionable whether less interest in spiders in females is associated with the fact that they are less interested in wild animals in general (Lindemann-Matthies, 2005), or whether fear of spiders alone influences other preferences. The former hypothesis is unlikely, because it has been found that gender differences among students are exaggerated, especially in attitudes towards controversial animals that pose the threat of injury to humans (Prokop & Tunnicliffe, submitted), but not to generally non-threatening animals like birds (Prokop et al., 2008). Considering that negativistic and scientistic attitudes towards controversial animals are linked (Prokop et al., 2009a), it can be speculated that increasing interest in spiders was linked with decreasing fear of spiders. Further research is needed to determine how increased interest in controversial animals like spiders influences attitudes toward them in both males and females.

The link between knowledge and attitudes

Our research provided evidence for a small, though statistically significant, effect of knowledge on attitudes towards spiders among Slovakian students. On the contrary, among South African students' scores there was only a weak relationship between knowledge and attitude. These results are consistent with our views about the conflict between awareness and evolutionary predisposition to avoid animals that pose physical threat and/or the possibility of disease transmission. We argue that if the probability of being threatened by a particular animal is high, then greater knowledge about this animal is not expected to be linked to attitude (Prokop & Tunnicliffe, 2008; Prokop et al., 2009a).

Previous research from Slovakia, however, showed no link between attitude towards and knowledge of spiders, when a nearly identical attitude scale was used (Prokop & Tunnicliffe, 2008). All correlation coefficients between knowledge and ecoscientistic, negativistic, naturalistic dimensions and knowledge were $r < 0.1$ (all p's > 0.17). However, this research was conducted on a sample of younger children. Considering that children's fears decrease with increase in age (Ferrari, 1986), it can be argued that greater fear in younger children could reflect the absence of the attitude – knowledge relationship. If so, this argument also supports our above- mentioned hypothesis that greater conflict between threat (mediated by fear) and knowledge do not result in a strong attitude-knowledge relationship.

In general, our study, like the research of Kuhlemeier et al., 1999; Makki et al., 2003; Brossard et al., 2005, supports the idea that there is no strong association between attitude and knowledge. At first glance this is surprising because students who know more about spiders are generally more interested in and less afraid of them. There are at least two explanations for this phenomenon. Firstly, attitudes towards animals at the age of our student sample are developing; they are not yet defined (Kellert, 1985). In the present study, an overall correlation for attitude and knowledge is 30. However, previous research by Prokop and Tunnicliffe (2008) found no correlation between attitude towards and knowledge of spiders. In summary, we expect that age-related changes in factual knowledge in young participants are not yet linked to attitudes and fears as these are not yet defined (Røskaft et al., 2003; Prokop et al., 2008). Secondly, the reputation of spiders among humans is worse than that of many other animals (Kirkpatrick, 1984; Davey, 1994; Muris et al., 1997). It is therefore probable that this example is somewhat specific and does not reflect general expectations such as the relationships between knowledge of and attitude towards the environment.

According to previously mentioned research, both types of education, providing information (Muris et al., 2008) and field trip experiences (Žoldošová & Prokop, 2006) significantly

influenced the students' fear of and/or interest in controversial animals. Further research focused especially on controversial animals would shed more light on the relationship between attitude and knowledge.

Conclusion

High school students' attitudes towards spiders showed several differences with respect to their country of origin, which should be driven by evolutionary pressures, or improved science education strategies. Irrespective of this, however, spiders were viewed negatively in each attitude dimension. The bad image of spiders is linked to non-supportive ecological attitudes which consequently may influence their (low) protection and the next generation's poor understanding of the role of arthropods in nature. Elimination of myths and enhancement of knowledge resulted in more positive attitudes, especially in Western cultures. It was repeatedly found that spiders are only rarely kept as pets (Prokop, Prokop, & Tunnicliffe, 2008; Prokop, Özel, & Usak, 2009). However, keeping various pets is associated with better knowledge and more favourable attitude towards wild (even less popular) animals (Prokop et al., 2009b; Prokop & Tunnicliffe, *in press*). We suggest that biology/science teachers should encourage children to keep spiders that can be obtained and reared easily. Special attention should be focused on children from black families, because these children showed greater fear of spiders than white children from Slovakia.

The research instrument presented in this paper may be useful in assessing student's knowledge and attitudes. Greater emphasis on research into teaching strategies about spiders (arthropods) in formal and informal biology settings and an improvement in teachers' knowledge about student's views of spiders would be beneficial in formulating new strategies on how to impart knowledge of these controversial animals. We hope that our study may be

useful in guiding curricular efforts, especially those concerned with the conservation of terrestrial environments.

For example, South Africa started the Spider Educate programme 10 years ago and has reached about 20 000 children from nursery schools to university level. Personal experiences of lecturers suggest that more knowledge helps to overcome fear. Emphasizing the "nicer side" of spiders (for example maternal care, colour change, etc.) as well as drawing their attention to beautiful spiders may help especially children to overcome their fear. Finally, our study suggests that planning educational strategies should take into account evolutionary pressures, which could be responsible for human attitudes toward wild animals.

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References

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

Barney, E. C., Mintzes, J. J., & Yen, C-F. (2005). Assessing knowledge, attitudes and behavior towards charismatic megafauna: The case of dolphins. *Journal of Environmental Education, 36*(2), 41–55.

Bexell, S.M., Jarrett, O.S., Lan, L., Yan, H., Sandhaus, E.A., Zhihe, Z., & Maple, T.L. (2007). Observing Panda play: implications for Zoo programming and conservation efforts. *Curator, 50* (3), 287-299.

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.

Byrnes, J., Miller, D., & Schaffer, W. (1999). Gender differences in risk-taking: A meta-analysis. *Psychological Bulletin, 125*, 367–383.

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

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences.* 2nd edn. Hillsdale, NJ: Lawrence Erlbaum.

Davey, G. C. L. (1994). The "disgusting" spider: the role of disease and illness in the perpetuation of fear of spiders. *Society & Animals, 2*(1), 17-25.

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.

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.

Dippenaar-Schoeman, A. S., & Jocqué, R. (1997). Afričan spiders, an identification manual. Biosystematics Division, ARC-Plant Protection Research Institute, Pretoria. Handbook 9, 392 pp.

Ferrari, M. (1986). Fears and phobias in children: Some clinical and developmental considerations. *Child Psychiatry and Human Development, 17(2),* 75-88.

Field, A. P., & Davey, G. C. L. (2001). Conditioning models of childhood anxiety. In W. K. Silverman & P. A. Treffers (Eds.) *Anxiety Disorders in Children and Adolescents: Research, Assessment and Intervention* (Pp 187-211). Cambridge: Cambridge University Press.

Fredrikson, M., Annas, P., Fischer, H., & Wik, G. 1996. Gender and ge differences in the prevalence of specific fears and phobias. *Behaviour Research & Therapy, 34*(1), 33–39.

Fredrikson, M., Annas, P., & Wik, G. (1997). Parental history, aversive exposure and the development of snake and spider phobia in women. *Behaviour Research and Therapy, 35*(1), 23–8.

Gajdoš P., Svatoň, J. & Sloboda K. (1999). Katalóg pavúkov Slovenska. Ústav krajinnej ekológie SAV (Bratislava), 337 pp.

George, D., & Mallery, P. (2001). SPSS for windows; Step by step. Allyn & Bacon, The United States of America.

Gerdes, A. B. M., Uhl, G., & Alpers, G. W. (2009). Spiders are special: fear and disgust evoked by pictures of arthropods. *Evolution and Human Behavior, 30,* 66–72.

Hawkes, K., O'Connell, J. F., & Blurton Jones, N. G. (1991). Hunting income patterns among the Hadza: big game, common goods, foraging goals and the evolution of the human diet. *Philosophical Transactions of the Royal Society of London, Series B, 334*, 243–251.

Herzog, H., and Burghardt, G. M. (1988). Attitudes towards animals: origins and diversity. *Anthrozoös, 1*(4): 214-222.

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.

Jenkins, E. (1990). Scientific literacy and school science education. *School Science Review, 71*, 43-51.

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 towards 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.

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.

Kirkpatrick, D.R. (1984). Age, gender and patterns of common intense fears among adults. *Behaviour Research & Therapy*, *22*(2), 141-150.

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.

Lindemann-Matthies, P. (2005). "Loveable" mammals and "lifeless" plants: How children's interest in common local organisms can be enhanced through observation of nature. *International Journal of Science Education, 27*(6), 655–677.

Lippa, R. A. (2002). *Gender, Nature, and Nurture.* Mahwah, NJ: Lawrence Erlbaum.

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.

Morgan, J.M., & Gramann, J.H. (1989). Predicting effectiveness of wildlife education programs: A study of students' attitudes and knowledge towards snakes. *Wildlife Society Bulletin, 17*(4), 501–509.

Muris, P., Steerneman, P., Merckelbach, H., & Meesters, C. (1996). The role of parental fearfulness and modeling in children's fear. *Behaviour Research and Therapy, 34*(3), 265-268.

Muris, P., Merckelbach, H., & Collaris, R. 1997. Common childhood fears and their origins. *Behaviour Research & Therapy, 35*(10), 929-937

Muris, P., Mayer, B., Huijding, J., & Konings, T. (2008). A dirty animal is a scary animal! Effects of disgust-related information on fear beliefs in children. *Behaviour Research & Therapy, 46*(1), 137-144

Nicholson, G.M., & Graudins, A. (2002). Spiders of medical importance in Asia-Pacific: Atracotoxin, latrotoxin and related spider neurotoxins. *Clinical and Experimental Pharmacology and Physiology, 29*(9), 785–794.

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

Nyffeler, M., Dean, D.A., & Sterling, W.L. (1987). Evaluation of the importance of the striped lynx spider, Oxyopes salticus (Araneae, Oxyopidae), as a predator in Texas cotton. *Environmental Entomology 16*(5), 1114–1123.

Öhman, A., Carlsson, K., Lundqvist, D., & Ingvar, D. (2007). On the unconscious subcortical origin of human fear. *Physiology & Behavior, 92*(1-2), 180–185

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

Prokop, P., Fančovičová, J., & Kubiatko, M. (2009a). Vampires are still alive: Slovakian student's attitudes toward bats. *Anthrozoös*, *22*(1), 19–30.

Prokop, P., Kubiatko, M., & Fančovičová, J. (2008). Slovakian pupils' knowledge of and attitudes toward birds. *Anthrozoös, 21*(3), 221–235.

Prokop, P., Özel, M., & Uşak, M. (2009). Cross-cultural comparison of student attitudes toward snakes. *Society and Animals, 17*(3), 224–240.

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., & 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*(2), 87-97.

Prokop, P., & Tunnicliffe, S. D. Effects of having pets at home on children's attitudes toward popular and unpopular animals. *Anthrozoös, in press.*

Randler, C., Ilg, A., & Kern, J. (2005). Cognitive and emotional evaluation of an amphibian conservation program for elementary school students. *Journal of Environmental Education, 37*(1), 43–52.

Reckase, M. D. (1979). Unifactor latent trait models applied to multifactor tests: Results and implications. *Journal of Educational Statistics, 4*(3), 207-230.

Renner, F. (1990). *Spinnen: Ungeheuer sympathisch* . Kaiserslautern: Verlag.

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.

Seligman M.E.P. (1970). On the generality of the laws of learning. Psychological Review, 77, 406-418.

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

Sivek, D. J. (2002). Environmental sensitivity among Wisconsin high school students. *Environmental Education Research, 8,* 155–170.

Swanagan , J. S. (2000). Factors influencing zoo visitors' conservation attitudes and behavior.

Journal of Environmental Education, 31, 26–31.

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.

Treffers (Eds.), *Anxiety disorders in children and adolescents: research, assessment and intervention* (pp. 187–211). Cambridge: Cambridge University Press.

Vetter, R.S., Visscher, P.K. (1998). Bites and stings of medically important venomous arthropods. *International Journal of Dermatology, 37*(7), 481 – 496.

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

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.

Appendix A. Tabulation of the modified (Prokop & Tunnicliffe, 2008) Spider Attitude Questionnaire (SAQ) divided to the four dimensions. Students are requested to respond to the following statements on a Likert five point scale. Negative items are scored in reverse order.

Scientistic	Positive (P) or negative (N) items
I would like to read a book about spiders	P
I would like to know more about large tropical spiders species	P
I would like to know how scientists investigate spiders	P
I would like to know more about the weaving behaviour of orb-spiders	P
I like watching natural history films about spiders	P
We should learn more about spiders in school	P
I would like to participate in an expedition to investigate spiders	P
Cronbach's α = 0.895	
Ecologistic	
Greater attention should be given to spider protection	P
Spiders are quite interesting animals	P
People should use fewer chemicals in order to allow spiders to live close to them	P
I would like to watch a spider constructing its web at night	P
Cronbach's α = 0.688	

Negativistic

When a spider is making a web in my window, I am unable to sleep	N
If I happen to find a spider in my room, I will probably run away	N
Spiders scare me more than other animals	N
I feel fine about catching a spider if I am wearing gloves	P
If somebody tells me that spiders are somewhere around me, I get nervous	N
I do not like pictures of spiders	N
Even the thought of touching a spider scares me	N

Cronbach's α = 0.818

Naturalistic

I would like to camp at a river near spiders	P
Capturing spiders is exciting	P
I would like to have some spiders in the roof of my house	P
I would like to live in a country with few spiders	N
I would rather avoid places with spiders	N
I would like to catch a spider with my bare hands	P

Cronbach's α = 0.762

Table 1. Differences in mean scores between schools calculated by ANCOVA (controlled for age). Values are means and standard errors (in parentheses). S = state school, † = Catholic school, ♀ = single sex schol (girls only), $^{**}p < .01$, $^{***}p < .001$, *ns* = non-significant.

	Slovakia					South Africa				
	A. Merici†	ESA†	Grammar^{s}	Health^{s}	$F_{3,349}$	St. Bede†	J. Martin†	St. Ursula†♀	Brescia†♀	$F_{3,377}$
Knowledge	3.37 (0.03)	3.32 (0.07)	3.54 (0.07)	3.30 (0.07)	1.71^{ns}	3.10 (0.04)	3.13 (0.06)	3.38 (0.04)	3.38 (0.03)	15.65^{***}
Scientistic	2.91 (0.07)	2.43 (0.17)	3.02 (0.16)	2.70 (0.16)	4.08^{**}	3.79 (0.08)	4.11 (0.13)	2.66 (0.10)	2.56 (0.07)	65.38^{***}
Negativistic	3.55 (0.08)	2.99 (0.19)	3.22 (0.18)	2.93 (0.18)	4.73^{**}	3.22 (0.08)	3.12 (0.13)	3.00 (0.09)	2.94 (0.07)	3.88^{**}
Naturalistic	2.47 (0.07)	2.23 (0.15)	2.37 (0.14)	2.17 (0.15)	1.12^{ns}	2.46 (0.07)	2.65 (0.12)	1.82 (0.09)	1.97 (0.07)	20.51^{***}
Ecologistic	2.63 (0.07)	2.13 (0.17)	2.58 (0.16)	2.10 (0.16)	4.19^{**}	2.97 (0.08)	3.23 (0.12)	2.59 (0.09)	2.75 (0.07)	8.11^{***}
n	233	38	42	41	-	115	43	82	142	-

Figure 1. Analysis of the students' overall responses to the SAQ. Likert scale 1 and 2 represent negative, 3 neutral, and 4 and 5 positive attitudes.

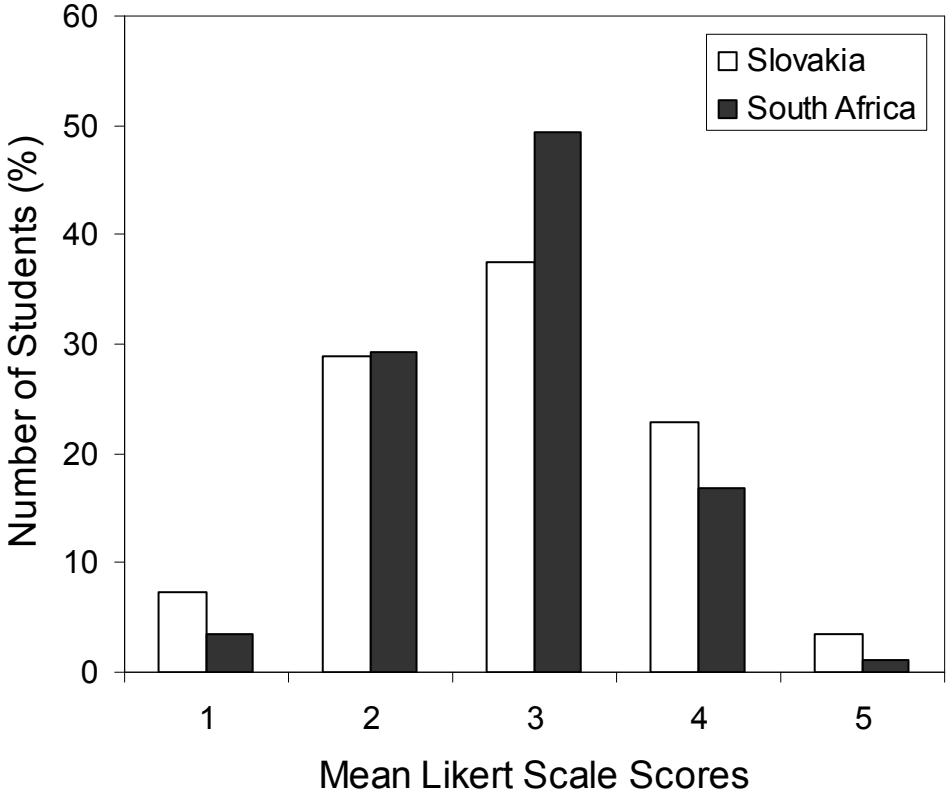

Figure 2. Mean residual score from four attitude dimensions with respect to gender and country. SK = Slovakia, AFR= South Africa.

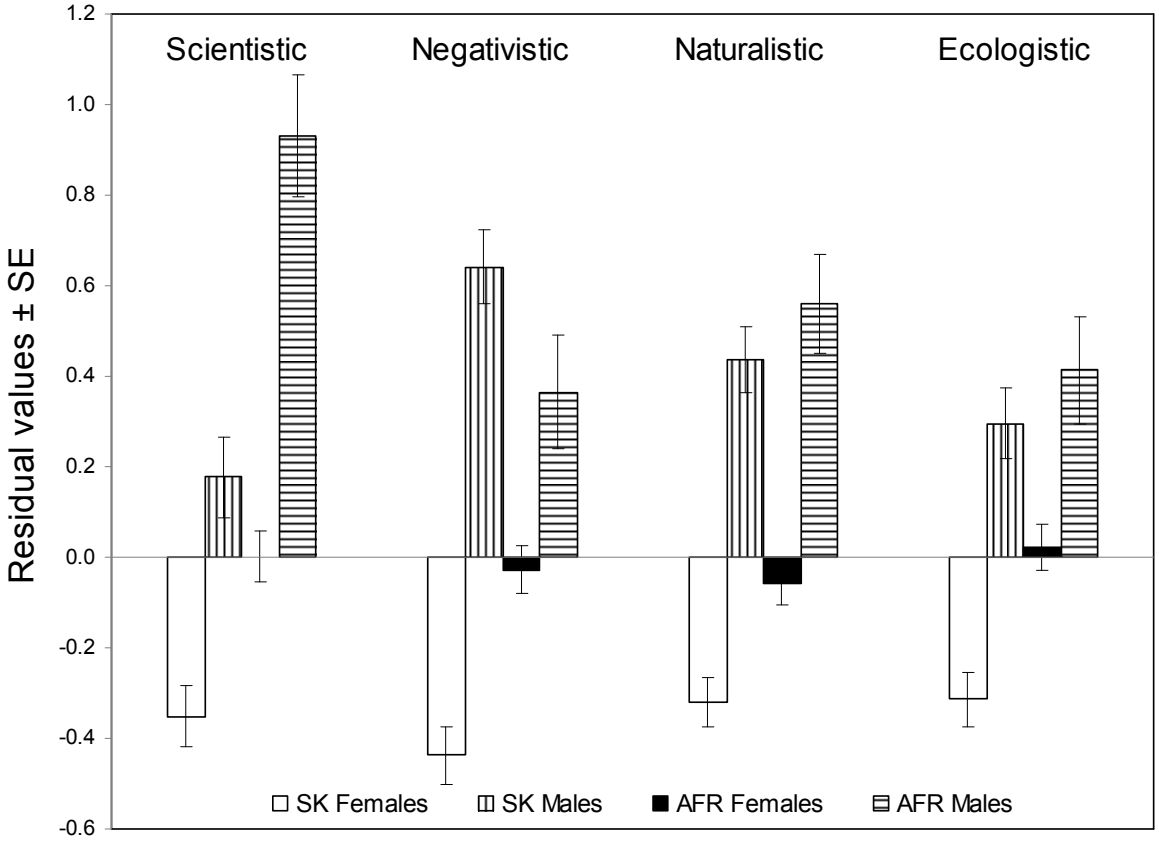

Figure 3. The relationship between knowledge and attitudes in Slovakia. Values are residuals of regression in which dependent variables (attitudes and knowledge) were controlled for the effect of school type and gender.

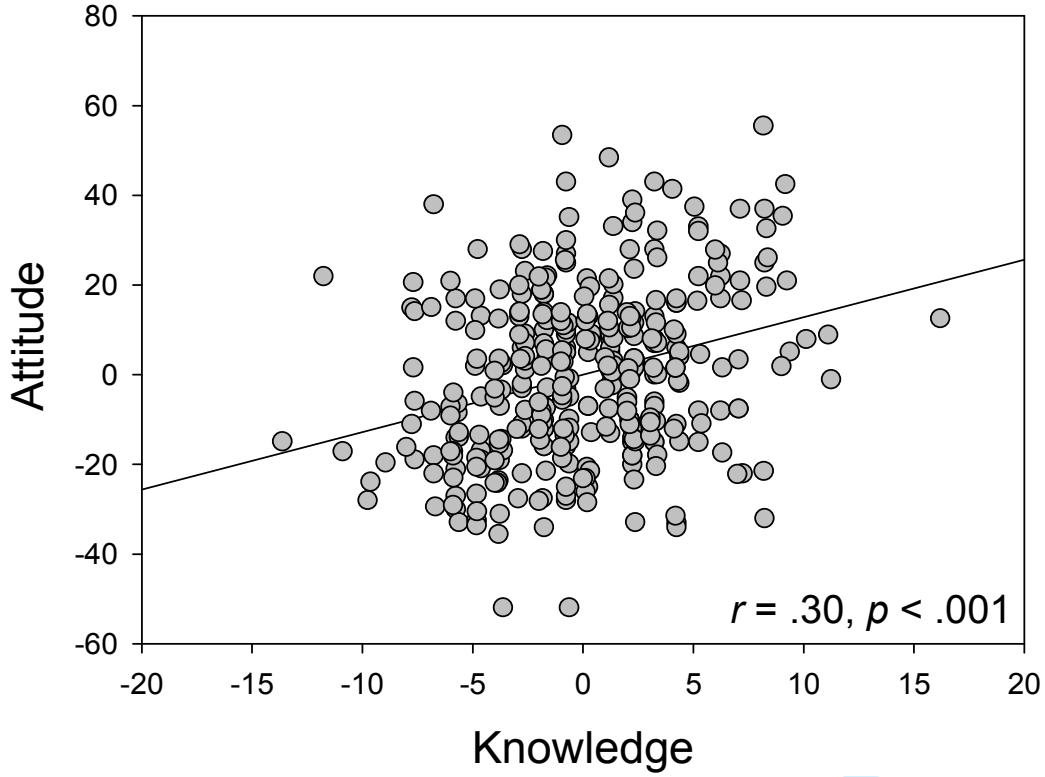

Figure 4. The relationship between knowledge and attitudes in South Africa. Values are residuals of regression in which dependent variables (attitudes and knowledge) were controlled for the effect of school type and gender.