Bad wolf kills lovable rabbits: children's attitudes toward predator and prey

Pavol Prokop
Trnava University
Slovak Academy of Sciences

Milan Kubiatko
Trnava University

Abstract

This cross-age study explores children's attitude toward a model predator (wolf) and prey (rabbit). We administered a Likert-type attitude questionnaire with 30 items (15 per predator and 15 per prey) to a total of 462 children aged 10 – 15 year in Slovakia. The mean score from three dimensions derived by a factor analysis (scientific, ecologistic and myths about parental care) was then subjected for pair wise comparisons. We found that younger children aged 10-11 year showed significantly more positive attitude toward a rabbit (prey) relative to wolf (predator). However, as children's age increased, the difference in means score disappear and positive attitudes toward predator and prey generally decrease. We hypothesize that these patterns could reflect either greater children's 'ecological thinking' or, more simply, decreasing interest toward animals in older children. The difference in attitudes toward predator and prey suggest that children's affective domain should not be neglected in future environmental programs, because attitudes influence pro-environmental behavior of future citizens.

Key words: attitudes, animals, predator, prey, ecology

Correspondence should be addressed to Pavol Prokop (Email: pavol.prokop@savba.sk), Department of Biology, Faculty of Education, Trnava University, Trnava, Slovakia,, or Milan Kubiatko (Email: mkubiatko@centrum.sk), Department of Biology, Faculty of Education, Trnava University, Trnava, Slovakia

Introduction

It is generally appreciated that teaching positive environmental attitudes and values is more important in bringing about change in environmental behaviour than the teaching of environmental knowledge (Ballantyne and Packer, 1996). Newhouse (1990) proposes that environmental attitudes can be changed by enduring positive or negative feeling about some object or person which means through affective domain. However, many of the research studies have been focused on children's *understanding* rather than *feeling* environmental problems although an emphasis on an affective domain should be considered in this field (Iozzi, 1989; Alsop and Watts, 2003).

It is based on the constructivist notion that all learning is a process of personal construction of children's existing knowledge (Fraser and Tobin, 1998). This

construction of knowledge takes place within a context of social interaction and agreement. In the process of construction, children develop relatively stable patterns of belief. They construct knowledge in ways that to them are coherent and useful. Children's explanation of natural phenomena, however, often differs from those of scientists (Fischer, 1985). These differing frameworks have been described as alternative conceptions. There are numerous works that showed that alternative conceptions are resistant to conventional teaching approaches and that they are found frequently among children, students or even teachers (Wandersee, Mintzes, & Novak, 1994). However, few works examined whether negative views or prejudice of animals influence attitudes toward them. Currently, for example, Prokop and Tunnicliffe (2008) examined children's attitudes toward spiders and bats, well known, 'disgusting' animals. They found significant correlation between untrue myths and attitudes, whereas more beliefs in myths resulted in more negative attitudes toward spiders and bats.

Relationships between predators and prey are fundamental parts of understanding food webs. To date, number of studies examined children's understanding of food webs (e.g. Griffiths and Grant, 1985; Leach *et al*., 1995, 1996a,b). It was found that children see simple linear causality when describing relationships in nature where only one population directly affects another (Adeniyi, 1985; Goldring and Osborne, 1994; Grotzer and Basca, 2003; Helldén, 2003). Leach *et al*. (1996b, p. 140) note that "pupils are more likely to infer changes to food webs up through trophic levels than down: lack of food causing starvation is a stronger cause – effect link than an absence of predators causing increased changes of survival". Palmer (1998) also has shown that high school students believe that a change in one population will only affect the other population if the two are related in a predatory–prey relationship and it will not affect several different pathways of a food web.

The teaching a role of predators in ecosystems has another dimension than only scientific understanding the importance of predators. Large carnivore predators have been viewed as human competitors through our evolutionary history (Breitenmoser, 1998) and, unfortunately, many hunters still show a negative attitude toward them (Ericsson and Heberlein, 2003; Naughton-Treves *et al.*, 2003). Some animals still agitate fear and initiate defensive responses (Öhman, 1986), because they might be have been dangerous to humans in prehistoric times (Morris and Morris, 1965, Shepard, 1997). Therefore, it is important to understand children's attitude toward particular animal, because children's knowledge and attitudes toward animals are closely related (Kellert, 1993; Thompson and Mintzes, 2002; Dimopoulos and Pantis, 2003) and anxiety from an animal correlate negatively with achievement (Randler *et al.*, 2005). Emotional appeals also may be more effective in changing attitudes formed on the basis of affect (emotion) than cognition-based arguments (Edwards, 1990).

Attitudes toward animals

An attitude can be generally defined as the tendency to think, feel, or act positively or negatively toward objects in our environment (Eagly and Chaiken, 1993; Petty, 1995). Social psychologists have long viewed 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 or physiological 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). Attitudes to animals are, however, traditionally measured using paper/pencil tests (e.g. Herzog, Betchart and Pittman, 1991). We therefore used standard psychometric procedures to measure children's attitudes using paper/pencil tests following Weinburgh and Steele (2000).

A specific way to investigate attitudes toward animals and factors influencing these attitudes has been proposed by Stephen Kellert (Kellert, 1976, 1985, 1993; Kellert and Westervelt, 1983). Kellert developed a descriptive analysis of nine fundamental attitudinal 'types' (Kellert, 1976). He also identified important changes in the development of children's perceptions of animals and found three transitions (Kellert, 1985). The first transition, (6 – 9 years of age) involves changes in affective and behavioural variables. The second transition from 10 to 13 years of age is typical by a major increase of cognitive abilities. The third transition (13 – 16 years of age) embraces an ethical concern and ecological awareness of the role of animals in their natural habitats. A brief description of Kellert's attitudinal types is provided below:

- *naturalistic:* interest in direct experience with animals and exploration of nature.
- *ecologistic:* concern for the environment as a system; for inter-relationships between wildlife species and natural habitats.
- *humanistic:* interest and strong affection for animals, with strong emotional attachment and 'love' for them.
- *moralistic:* concern for the right and wrong treatment of animals, with strong opposition to exploitation or cruelty toward animals.
- *scientific:* interest in the physical attributes and biological functioning of animals.
- *aesthetic:* interest in the artistic and symbolic characteristics of animals.
- *utilitarian:* concern for the practical and material value of animals; their body parts and/or habitats.
- *dominionistic:* interest in the mastery and control of animals, as in sporting or other competitive contexts.
- *negativistic:* orientation toward an active avoidance of animals as a result of indifference, dislike or fear.

Purpose

Attitudes toward wolf itself have been investigated in several countries (for a review, see Williams et al., 2002). However, no study investigated how attitudes toward predator and prey differ and change over the children's life. This is however an intriguing question, because predators are essential elements for understanding ecological relationships. Peoples' beliefs about the object determine their attitudes toward it (Pooley, 2000). Thus, it is important what children know about predator - prey

relationship, but feeling or the affective domain may significantly influence their future attitudes and behaviour (Kraus, 1995). From the environmental education perspective, it is essential to investigate what children feel about predators, not just what they know, because there is much stronger correlation between environmental attitude and behaviour rather than between environmental knowledge and behaviour (Kraus, 1995). In this study, we used a wolf as example of well known predator, and a rabbit, as an example of well known prey to examine differences of children's perception of predators and prey.

We have chosen to focus this study on wolves because they can benefit substantially from effective conservation education programmes. Wolves are rare predators with decreasing population at lest in Slovakia and surrounding countries. Unfortunately, wolves suffer from a negative 'public image' (Bjerke et al., 1998) (unlike domestic dogs), which works to reduce wolf populations rather than to conserve them.

Research Questions

The present study focuses on answering following questions:

1. Are there any differences in children's attitudes toward predator and prey?
2. How much do children's attitudes toward predator and prey change from fifth (age 10/11) to ninth (age 14/15) grade?
3. Are there any differences in children's attitudes toward predator and prey differ with respect to gender?

Method

Construction of the Questionnaire

We measured children's attitudes toward wolf and rabbit by Likert-type items developed similarly to Kellert's (1985) attitude scale toward animals. The questionnaire consists from 30 items (15 item for rabbit and 15 for wolf) that were scored by participants from 1 (strongly disagree) to 5 (strongly agree). Items were either formulated as positive (e.g. "I like natural history films about wolves") and negative (e.g. "Wolves have negative impact on other animals in ecosystem") following suggestions by Likert (1932), Hausbeck et al. (1992) and Oppenheim (1993).

Negative items were scored in the reverse order. Two professors of zoology from two different universities and two biology teachers independently and separately checked items in order to maintain validity of research instrument. Their suggestions and improvements were accepted and final version of the questionnaire was altered accordingly. We tried to use similar items for both wolf and rabbit which would allow us to compare them with paired statistics. Many of items were identical, but in some cases items differ. We notice these differences in text. The differences were especially in food habits of both two animals which greatly differ. Because children tend to have some difficulties with double negative items, classroom teacher who administered questionnaires instructed children about meaning of some of these items.

Score from the questionnaire was analyzed by factor analysis with Varimax rotation for both wolf and rabbit separately. Five factors loaded for rabbit and five for wolf. We deleted all items below factor loadings 0.38 and all other items that loaded with more than one factor were also deleted (Palaigeorgiou et al., 2005). In total, four items per a rabbit and four items per a wolf were omitted. Only factors that were represented at least by three items were accepted for further consideration.

Three dimensions, scientific, ecologistic and myths about parental care, for each wolf and rabbit were loaded and used for pair wise comparisons (Table I and II). The Cronbach's alpha of whole items for wolves (0.74) and for rabbit (0.70) showed appropriate reliability (Nunnaly, 1978). Reliabilities for each dimension are shown in Table 1 and 2. The Cronbach's alpha for the ecologistic dimension is relatively lower, and some caution must be made when interpreting these data.

Table 1
Factor structure of children's attitudes toward wolves

Items	Scientific α = 0.76	Ecologistic α = 0.48	Myths about parental care α = 0.5
I would like to rear a wolf	0.51		
I would like to know more about wolves	0.72		
Wolves are attractive animals	0.73		
I like natural history films about wolves	0.77		
I would like to participate on an expedition for investigating wolves	0.76		
Wolves have negative impact on other animals in ecosystem		0.73	
Wolf is important for stability of ecological relationships in nature		0.55	
Wolf kills only bigger animals such as deer, pigs, etc.		0.86	
Female wolf often kills her offspring, it is therefore said 'wolf's mother'			0.45
Wolf female does not feed her offspring and they therefore kill each other and only the best wolf survives			0.4
Wolf female very much caries of her offspring			0.8
Eigenvalue	4.28	1.7	1.3

Table 2
Factor structure of children's attitudes toward rabbits

Items	Scientific	Ecologistic	Myths about

	α = 0.79	α = 0.43	parental care α = 0.49
I would like to rear a rabbit	0.66		
I would like to know more about rabbits	0.76		
Rabbits are attractive animals	0.40		
I like natural history films about rabbits	0.79		
I would like to observe life history of rabbits in the field	0.81		
Rabbits are important for stability of ecological relationships in nature		0.47	
Rabbits are important for regulation of other organisms in ecosystems		0.63	
Rabbits eat away the bark of trees		0.72	
Rabbits are important part of nature			0.78
Rabbit female very much caries of her offspring			0.55
Rabbit female protects her offspring even she risks her life			0.39
Eigenvalue	4.99	1.56	1.15

Sample

The study was conducted between March and May 2006. A total of 462 children (225 boys and 237 girls) from five different age classes (grade 5 – 9, age 10 – 15) participated in the study. Children were selected randomly from 6 typical Slovak schools from various regions in Slovakia as whole classes to avoid potential bias of children more or less interested in biology. The number of participants with respect to grade level was similar (5 – 9 grade, N = 81, 85, 101, 85, 110, respectively). After teachers agreed with participation in our research, one of us visited the school and administered a questionnaire about attitudes toward predator and prey. The children were also asked for basic information about their age/grade and gender. To avoid social desirability in answering questions the questionnaire was anonymous (Streiner and Norman, 1989).

Children were not time limited during completing a questionnaire. Because between-schools data did not show significant differences, data from all schools were pooled.

Results

Scientific attitudes toward wolf and rabbit

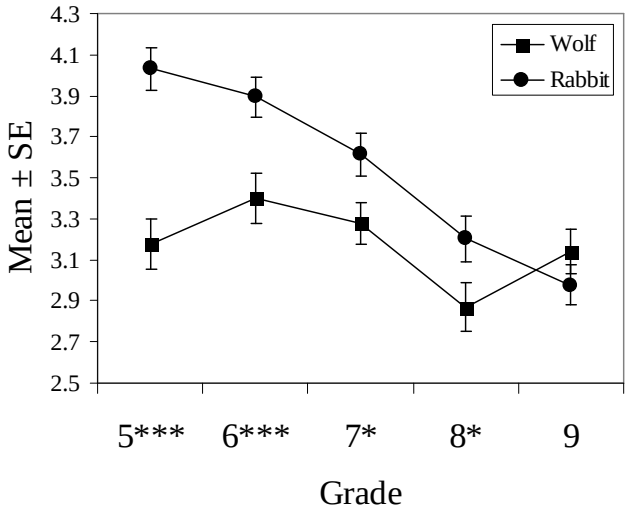
A two-way ANOVA with gender and grade as factors and score from wolf and rabbit's scientific attitude showed significant effect of both gender ($F(2,451) = 7.44$, $p < 0.001$) and grade ($F(8,902) = 10.57$, $p < 0.0001$). An interaction between gender × grade was not significant ($F(8,902) = 1.39$, $p = 0.2$). Boys showed more positive attitudes toward wolf than did girls (mean score = 3.35 ± 0.07 vs. 3.00 ± 0.07, Tukey post-hoc test, $p = 0.003$). Effect sizes calculation showed that this difference was of small - medium size (Cohen's $d = 0.27$). This means that about 60 % of boys exceed the score of the average girl (Cohen, 1988). On the contrary, girls' scientific attitudes toward rabbit tended to be higher that that of boys' (mean score = 3.6 ± 0.07 vs. 3.48 ± 0.07, Tukey post-hoc test, $p = 0.07$), but the effect size was very small ($d = -0.15$). Differences between grades, as indicated by Tukey post-hoc test, were clearly significant only for the rabbit; in case of wolf only 6th graders showed significantly more positive attitudes than 8th graders ($p = 0.01$), but other differences were not statistically significant. Attitudes toward rabbit conspicuously decreased as age of children increased (Fig. 1).

Mean attitude score suggest that scientific attitudes toward rabbit were more positive that that of wolf except for the 9th grade. As shown in Figure 1, attitudes toward predator and prey in 9th grade were very similar showing no statistical difference. The highest differences were found among 5th and 6th graders (age 10 – 12), who showed very positive attitudes toward a rabbit, but rather neutral attitudes toward a wolf.

Children consider rabbits generally more attractive than wolves (76 vs. 50% of all children) and want to breed rabbit more likely than wolf (52 vs. 33%). In contrast, direct observations of rabbits and wolves in nature attracted similar number of children (54 vs. 50 %) and little more children like natural history films about wolves relative to rabbits (50 vs. 46%).

Figure 1
Children's scientific attitudes toward wolf and rabbit

Asterisks denote significant difference between mean wolf and rabbit's score based on paired t-test. * $p < 0.05$, *** $p < 0.001$.



Ecologistic attitudes toward wolf and rabbit

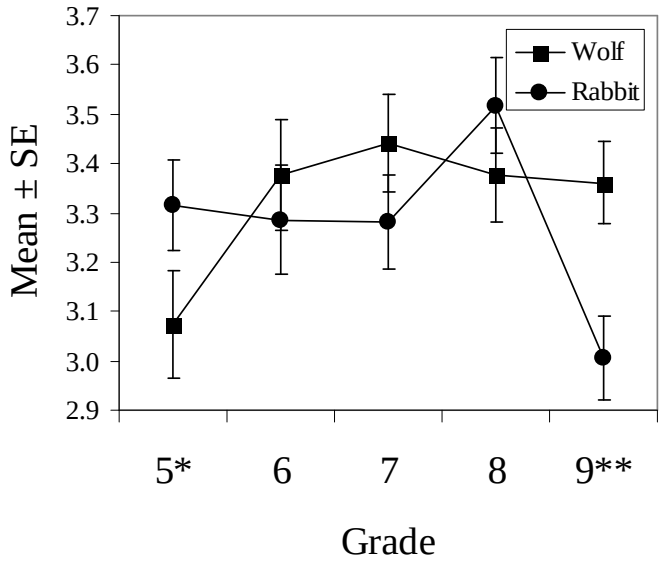
A two-way ANOVA with gender and grade as factors and score from wolf and rabbit's scientific attitude showed significant effect of both gender ($F(2,451) = 7.14$, $p < 0.001$) and grade ($F(8,902) = 2.81$, $p < 0.01$). An interaction between gender × grade was not significant ($F(8,902) = 0.59$, $p = 0.78$). Boys and girls showed a similar attitude toward wolves (3.37 ± 0.06 vs. 3.27 ± 0.06, Tukey post-hoc test, $p = 0.25$, $d = 0.11$), but boys showed more positive attitudes toward rabbit than did girls (3.44 ± 0.06 vs. 3.12 ± 0.06, Tukey post-hoc test, $p < 0.001$). The effect size was also of medium size ($d = 0.37$) which means that more than 60 % of boys exceed the score of the average girl. Age related differences showed very weak variance; Tukey post-hoc test failed to show any difference for wolf, and only one difference (between grade 8 and 9) was shown for a rabbit (Fig. 2).

Mean attitude score suggests that ecologistic attitudes toward wolf and rabbit are similar. Only 5th graders showed less positive attitudes toward wolf relative to rabbit and the reverse was found for 9th graders.

Relative more children favoured the importance of rabbits in ecological relationships in nature (64 vs. 43% of all children), but a similar number of children (about 50%) reported the importance of wolf and rabbit in the regulation of other organisms in the ecosystem. Food habits seem to be less understood, because only 30 % of all children knew that rabbit eat away the bark of trees and about 50 % thought that wolf forage only on higher mammals such as deer, etc.

Figure 2
Children's ecologistic attitudes toward wolf and rabbit

Asterisks denote significant difference between mean wolf and rabbit's score based on paired t-test. * $p < 0.05$, ** $p < 0.01$.



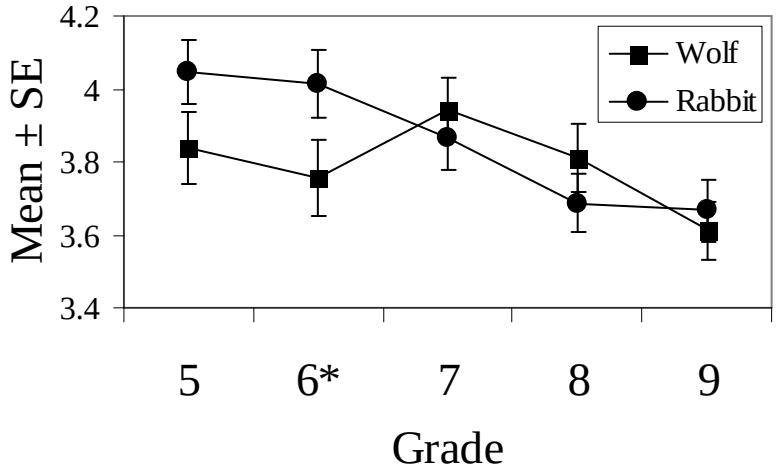
Myths about parental care in wolves and rabbits

A two-way ANOVA with gender and grade as factors and score from wolf and rabbit's myths about parental care showed significant effect of grade (age) ($F_{(8,902)} = 3.1$, $p \leq 0.001$), but not effect of gender differences ($F_{(2,451)} = 0.48$, $p = 0.62$). Both boys and girls showed positive mean scores toward wolf (3.76 ± 0.06 vs. 3.83 ± 0.06) and rabbit (3.83 ± 0.06 vs. 3.87 ± 0.05). Interaction between gender × grade ($F_{(8,902)} = 1.22$, $p = 0.28$) did not show significant effect. A Tukey post-hoc test showed no differences between children's attitude toward wolf with respect to different grades. However, several statistically significant differences were found for rabbits whereas most positive attitudes were found for 5 and 6 grade children. Older children had less positive attitudes relative to younger ones. Mean score for rabbits and for wolves generally did not significantly differ except for grade 6, and non-significant tendency was found in grade 5. These data should be interpreted cautiously, because not all items in this dimension were identical.

While 60 % of children agreed that female wolf take great care of her offspring, relative more children (72 %) showed the same belief for female rabbit. Paired t-test for these two identical items showed significantly higher score of rabbits ($t = -4.21$, $df = 463$, $p < 0.0001$). Surprisingly, 64 % of children believe that female wolf often kills her own offspring, it is therefore said 'wolf's mother'. The same number of children thought that female wolf does not feed her offspring to encourage them to kill each other and therefore only the 'best' wolf survives. In contrast, the same proportion of children see female rabbit nearly self-sacrificing when protect her own offspring.

Figure 3
Children's myths about parental care in wolves and rabbits

Asterisks denote significant difference between mean wolf and rabbit's score based on paired t-test. * $p < 0.05$



Relationships between attitude dimensions

We performed a series of Pearson correlation coefficients to examine inter-relationships between attitude dimensions of wolf and rabbit. Correlations between wolf's and rabbit's scientific ($r = 0.21$), ecologistic ($r = 0.23$) and myths ($r = 0.2$) attitudes showed statistically significant correlations (all $p < 0.001$).

Discussion

Analysis of children's attitudes toward a model predator and prey showed that rabbit (prey) was relatively more positively perceived than wolf (predator), especially by the younger children aged 10 – 11. Generally, Slovakian children expressed rather positive or neutral attitudes toward both predator and prey, while children's age also seems to play an important role in attitude change. This information might be useful for curriculum developers and environmental educators who are concerned in preservation of predators or other animals that are endangered by negative public attitudes.

The relative higher preference for rabbit reflects human preference for small animals (Bjerke and Østdahl, 2004) although dog is also one of the most preferred animal species (Bjerke and Østdahl, 2004) and most frequently keeping pet in Slovakia (Prokop et al., 2008). Despite wolves are silent, bashful and intelligent predators, they sometimes cause serious injuries or deaths to humans (e.g. McNay, 2002) and/or domestic animals (e.g. Treves et al., 2002). Direct interference and competition with humans can explain wolves' negative image in myths and folklore. Research on attitudes toward wolves also show that humans living in closer proximity with wolves, and especially hunters and those who are keeping livestock, show more negative attitudes than others (Ericsson and Heberlein, 2003; Røskaft et al., 2003). In contrast, rabbit is a small, physically harmless and one of the ten most preferred pets among Slovakian children (Prokop et al., 2008).

These strong differences result in less positive attitudes toward wolves, especially for girls in scientific dimension. Moreover, children generally prefer domestic rather than wild animals (Paraskevopoulos et al., 1998). Boys, but not girls, like less-preferred animals such as snails, bats or rats (Bjerke and Østdahl, 2004) and this is probably the case, why boys scored better toward wolf in scientific dimension. Adult females also express greater fear toward wolves in comparison with males (Røskaft et al., 2003), but we did not find any support for this prediction in a sample of Slovakian children. Girls just scored better in interest toward a rabbit (the scientific dimension) which corroborate previous finding that girls exhibit greater interest on rearing pets than boys (Lindemann-Matthies, 2005; Prokop et al., 2008). In contrast, boys scored better in ecological attitudes toward rabbit which can be partly explained by greater interest of boys toward native, wild animals (Lindemann-Matthies, 2005).

Our data confirm Kellert's (1985) description of age – related differences in children's attitudes toward animals. The great difference in perception of predator and prey disappeared when children's age increased which may reflect a switch from affective to cognitive abilities. This finding also correlate with children's 'ecological thinking' that develop around age of 9 – 12 (Leach et al., 1996a). This is also supported by the greater differences in mean score for ecological dimension in grade 5 (age 10) and the absence of such difference in grade 6, 7 and 8. In addition, there was a statistically significant correlation for each dimension between both wolves and rabbit's score which suggest that greater ecological thinking equally influenced attitudes toward predator and prey. Thus, fewer differences in mean score between wolf and rabbit would reflect better understanding of the role of predator and prey in ecosystems. However, children's interest toward animals (both wolves and rabbits) measured by the scientific and myths dimension decreased with increasing age. This would reflect generally lower participation of older children in animal - related activities (Bjerke et al., 2001). Older children should have greater understanding of ecology, but, considering the fact that it is unclear whether attitudes lead to increased knowledge or vice versa (Zimmermann, 1996), we cannot reject or support 'ecological thinking' nor 'decreasing interest' hypothesis. Further research in this area is therefore needed.

Correlations between attitude dimensions imply that more scientific interest in a wolf result in greater appreciation of wolves in nature. Science educators should encourage children's interest in wolves for example through their observations in zoological gardens through project learning. Gathering information supported by direct observations and their presentation to other children in the classroom would result in better understanding of the role of wolves in ecosystems. Morgan and Gramman (1989) for example found that participation on an environmental program focused on the ecology of snakes significantly improved children's attitudes toward them.

Additionally, it is unclear whether children understand phylogenetical relationship between domestic dogs and their predecessor, a wolf. Dogs are most frequently owned pets in Slovakia (Prokop et al., 2008) which would be meaningfully utilized in formal science education lessons to explain evolution of relationships between humans and wolves.

Conclusion

Both predators and prey play a fundamental role in ecosystems and, consequently, in ecological education. All animals, regardless of their familiarity with human, play important role in food webs and contribute to biodiversity and ecological stability of the nature. Children's attitudes to animals may later influence public behaviour (Thompson and Mintzes, 2002), building of positive attitudes is therefore necessary for increasing pro-environmental behaviour of future citizens. Our results suggest that attitudes toward a model predator are less positive than attitudes toward 'lovable' animals like a rabbit. This means that the feeling toward animals requires more attention of science teachers, environmental educators and researchers, because environmental strategies of each state depend on changing of peoples' behaviour and attitudes. Predators, unlike phytophagous animals, are often food deprived in the field (e.g. Wise, 1993). Children are however not enough sensitive for these facts and think that predators are 'bad' because they kill other animals. We suggest that participation in non-formal biology settings perhaps in zoological gardens or environmental programs for endangered mammals would have positive effect on children's attitudes and possibly on public behaviour toward large carnivore predators. Further research on the role of movies or environmental interventions in building children's attitudes to predators is necessary.

References

Adeniyi, E. O. (1985). Misconceptions of selected ecological concepts held by Nigerian students. Journal of Biological Education. 19(4), 311–316.

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

Ballantyne, R. R., & Packer, J. M. (1996). Teaching and learning in environmental education: developing environmental conceptions. Journal of Environmental Education. 27(2), 25–32.

Bjerke, T., Kaltenborn, B. P., & Odegardstuen, T. S. (2001). Animal-related activities and appreciation of animals among children and adolescents. Anthrozoos. 14(2), 86–94.

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

Bjerke, T., Reitan, O., & Kellert, S.R. (1998). Attitudes toward wolves in south-eastern Norway. Society and Natural Resources. 11(2), 169–178.

Breitenmoser, U. (1998). Large predators in the Alps: The fall and rise of man's competitors. Biological Conservation. 83(3), 279–289.

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

Dimopoulos, D. I., & Pantis, J. D. (2003). Knowledge and Attitudes Regarding

Sea Turtles in Elementary Students on Zakynthos, Greece. Journal of Environmental Education. 34 (3), 30–38.

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

Edwards, K. (1990). The interplay of affect and cognition in attitude formation and change. Journal of Personality and Social Psychology. 59(2), 202–216.

Ericsson, G., & Heberlein, T. A. (2003). Attitudes of hunters, locals, and the general public in Sweden now that the wolves are back. Biological Conservation. 111(2), 149–159

Fisher, K. M. (1985). A misconception in biology: Amino acids and translation. Journal of Research in Science Teaching. 22(1), 53–62.

Fraser, B. J., & Tobin K. (1998). International Handbook of Science Education. Dordrecht, The Netherlands: Kluwer.

Goldring, H., & Osborne, J. (1994). Students' difficulties with energy and related concepts. Physics Education. 29(1), 26–32.

Griffiths, A. K., & Grant, B. A. C. (1985). High school students' understanding of food webs: identification of learning hierarchy and related misconceptions. Journal of Research in Science Teaching. 22(5), 421–436.

Grotzer, T. A., & Basca, B. (2003). How does grasping the underlying causal structures of ecosystems impact students' understanding? Journal of Biological Education. 38(1), 16–29.

Hausbeck, K. W., Milbrath, L. W., & Enright, S. M. (1992). Environmental knowledge, awareness and concern among 11th-grade students: New York State. Journal of Environmental Education. 24(1), 27–34.

Helldén, G. (2003). Personal context and continuity of human thought as recurrent themes in a longitudinal study. Scandinavian Journal of Educational Research. 47(2), 205 -217.

Herzog, H., Betchart, N., & Pittman, R. (1991). Sex role identity and attitudes toward animals. Anthrozoös. 4(3), 184–192.

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.

Kellert, S. R. (1976). Perceptions of animals in American society. Transactions of the North American Wildlife and Natural Resources Conference. 41, 533–546.

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

Kellert, S. R., & Westervelt, M. O. (1983). Children's attitudes, knowledge and behaviours toward animals. Children's Environments Quarterly. 1 (1), 8–11.

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

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.

Leach, J., Driver, R., Scott, P., & Wood-Robinson, C. (1995). Children's ideas about ecology 1: Theoretical background design and methodology. International Journal of Science Education. 17(6), 721–732.

Leach, J., Driver, R., Scott, P., & Wood-Robinson, C. (1996a). Children's ideas about ecology 2: Ideas found in children aged 5–16 about the cycling of matter. International Journal of Science Education. 18(1), 19–34.

Leach, J., Driver, R., Scott, P., & Wood-Robinson, C. (1996b). Children's ideas about ecology 3: Ideas found in children aged 5 – 16 about the interdependency of organisms. International Journal of Science Education. 18(2), 129–141.

Likert, R. (1932). A technique for the measurement of attitudes. Archives of Psychology. 27 (140), 1–55.

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.

McNay, M. E. (2002). Wolf-human interactions in Alaska and Canada: a review of the case history. Wildlife Society Bulletin. 30 (3), 831–843.

Morgan J. M., & Gramman, J.H. (1989). Predicting effectiveness of wildlife education programs - A study of students' attitudes and knowledge toward snakes. Wildlife Society Bulletin. 17, 501–509.

Morris, R., & Morris, D. (1965). Men and snakes London: Hutchinson & Co.

Naughton-Treves, L., Grossberg, R., & Treves, A. (2003). Paying for tolerance: rural citizens' attitudes toward wolf depredation and compensation. Conservation Biology. 17(6), 1500–1511.

Newhouse, N. (1990). Implications of attitude and behavior research for environmental conservation. *Journal* of *Environmental Education*. 22(1), 26–32.

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

Öhman, A. (1986). Face the beast and fear the face: Animal and social fears as prototypes for evolutionary analyses of emotion. Psychophysiology. 23(2), 123–145.

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

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.

Palmer, J. A. (1998). Environmental education in the 21st century — Theory, practice, progress and promise. London: Routledge.

Paraskevopoulos, S., Padeliadu, S., & Zafiropoulos, K. (1998). Environmental knowledge of elementary school students in Greece. Journal of Environmental Education. 29(3), 55–60.

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.

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 & Technology Education, 4(2), 87–97.

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(4), 43–52.

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.

Shepard, P. (1997). The Others. Washington, DC: Island Press.

Streiner, D. L., & Norman, G. R. (1989). Health measurement scales. A practical guide to their development and use. New York: Oxford University Press.

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.

Treves, A., Jurewicz, R. R., & Naughton-Treves, L. (2002). Wolf depredation on domestic animals in Wisconsin, 1976-2000. Wildlife Society Bulletin. 30(1), 231–241.

Wandersee, J. H., Mintzes, J. J., & Novak, J. D. (1994). Research on alternative conceptions in science. In D. Gabel (Ed.), Handbook of research on science teaching and learning (pp. 177–210). New York: Macmillan.

Weinburgh, M. H., & Steele, D. (2000). The modified attitude toward science inventory: Developing an instrument to be used with fifth grade urban students. Journal of Women and Minorities in Science and Engineering. 6(1), 87–94.

Williams, C. K., Ericsson, G., & Heberlein, T. A. (2002). A quantitative summary of attitudes toward wolves and their reintroduction (1972-2000). Wildlife Society Bulletin. 30(2), 575–584.

Wise, D. H. (1993). *Spiders in Ecological Webs*. Cambridge Studies in Ecology, Cambridge University Press. Cambridge (UK).

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