

Schoolchildren and One of the Most Unpopular Animals: Are They Ready to Protect Snakes?

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ABSTRACT For cultural reasons and due to the narrow vision of environmental policy makers, most conservation efforts focus on a few charismatic species and consequently neglect the majority of others under threat; many unpopular species are even killed in large numbers with little concern. Redressing this bias through educational programs is therefore important. Snakes are unpopular animals; they suffer from human harassment in most places and many populations have declined worldwide. Consequently, they provide suitable substrate to better improve conservation education in schoolchildren. Responses to a questionnaire administered to 2,570 schoolchildren (7–14 years old) from 10 countries showed that many children liked snakes and that most of the students wanted to see snakes protected. Such counterintuitive results were supported by the explanations given by the children, notably the reasons they liked or disliked snakes. Previous physical contact with snakes was often associated with snake likeability. We also found strong and expected differences between countries: for instance, where venomous snakes represented a health risk, most children declared to be afraid of snakes. Overall, our results negate the simplistic, and previously unverified, adult view that snakes are necessarily perceived as frightening animals, thereby justifying their persecution. This study provides an encouraging message, suggesting that it is not compulsory to focus on charismatic animals to convince children to protect wildlife.

Keywords: attitudes, children, conservation, environmental education, snake



People express complex and sometimes contradictory or irrational attitudes towards animals (Tisdell and Xiang 1998). For instance, a charismatic species like the Indian elephant can be perceived as a pest, a valuable resource, and/or a loveable animal (Swanagan 2000; Bandara and Tisdell 2003; Lindemann-Mathies 2005). As expected, there is a strong, positive association between the level of likeability of a species and conservation concern, which in turn affects practical actions in the field (Wilson and Tisdell 2005; Tisdell, Wilson and Nantha 2006; Martín-López, Montes and Benayas 2007). More generally, public perception of species (both general public and residents) is a strong determinant of conservation policies; it is therefore of prime importance to investigate this issue (Reiter, Brunson and Schmid 1999; Tisdell, Swarna Nantha and Wilson 2007).

As schoolchildren are far more receptive to information than adults, they should be one of the main targets of environmental education programs (Feinsinger 1987; Jacobson and McDuff 1998). Children's attitudes towards animals are strongly influenced by various and often intermingled factors including culture, beliefs, media, and animal's appearance (Prokop and Tunnicliffe 2008, 2010; Ballouard, Brischoux and Bonnet 2011). In practice, children's concerns about animals are limited to a very narrow range of species (Balmford et al. 2002; Ballouard, Brischoux and Bonnet 2011). Education oriented towards non-popular species which can contribute to redressing such a deleterious taxonomic bias is therefore needed (Feinsinger 1987; Kellert 1993; Ballouard, Brischoux and Bonnet 2011).

Few species are popular: mammals and birds attract far more support and funding than the overwhelmingly more diverse and highly threatened array of invertebrates, for instance; and many mammal (e.g., rodents) and bird species are neglected (Clark and May 2002; Tisdell, Wilson and Nantha 2005). Although iconic species have a strategic role to play in helping raise funds for conservation projects, an exclusive focus on charismatic animals can also have a negative impact on reaching general conservation objectives, because of a taxonomic parochialism effect (Williams, Burgess and Rahbek 2000; Clark and May 2002; Stokes 2007; Taborsky 2009). Indeed, resources for conservation are limited, biodiversity conservation suffers from a strong, negative taxonomic bias, and some animals are consequently neglected in conservation programs (Clark and May 2002; Seddon, Soorae and Launey 2005; Marešová and Frynta 2007).

The current number of iconic species is limited and unlikely to provide the desired indirect protection for a greater range of species (via an umbrella effect). Furthermore, many species are unappreciated or disliked, and the concurrent existence of endearing species is unlikely to alter this attitude. For example, invertebrates are mostly associated with fear, antipathy, and aversion (Kellert 1993). To redress detrimental taxonomic bias, it is essential to convince people of the value of species diversity, and consequently to focus on those less popular species (Kellert 1993, 1996). Snakes are among the best candidates for such an endeavor. Firstly, they are among the least popular animals, they suffer from a negative image, fear and phobia are common responses, and they are killed or tormented in large numbers in many countries (Morris and Morris 1965; Seshadri 1984; Shalev and Ben Mordehai 1996; Gomez, Larsen and Walton 2004; Christoffel 2007; Prokop, Özel and Uşak 2009; Yorek 2009). Secondly, snakes are facing a worrying worldwide decline (Reading et al. 2010). Thus, improving public opinion of snakes is not only essential in terms of general attitudes, but also in terms of species conservation (Morgan and Gramann 1989; Kaplan 1997; Gomez et al. 2004; Mullin and Seigel 2009).

Several studies have attempted to explain the origin of the widespread and strong negative perceptions about snakes. It has been argued that the fear of snakes in humans is an evolutionary history legacy: the fear of snakes being deeply encoded in our genome (Öhman and Mineka 2003; Isbell 2006; Marešová, Antonin and Frynta 2009; Masataka, Hayakawa and Kawai 2010; Hayakawa, Kawai and Masataka 2011). However, this notion that snakes are necessarily perceived as major threats (Öhman, Flykt and Francisco 2001; Lobue and Deloache 2008; Shibasaki and Kawai 2009) is simplistic and largely limited to recent occidental culture (Morris and Morris 1965; Tisdell, Swarna Nantha and Wilson 2006).

Snakes have been venerated over extremely prolonged periods of time; they are still major, positive divinities in many cultures and are an important source of food in many places (Klemens and Thorbjarnarson 1995; Bonnet 2007). Although a wide range of circumstances exist, a survey of the relationships between human beings and snakes revealed that they are far more often associated with positive symbols (water, knowledge, eternity, fertility, health, etc) than with negative symbols, across human cultures and across time (Bonnet 2007). The continuing media domination by occidental cultures, which has generated many irrational and negative beliefs (about several animal species notably), most likely explains the general negative attitude towards snakes that exists today, rather than a putative and yet undemonstrated genetic legacy. Indeed, most media, including documentaries, still propagate the false image that all snakes are slimy, cunning, venomous, and deadly animals; even in countries where no venomous snakes occur. In fact, snake-related events covered by the media are highly biased towards negative events (e.g., about snake bites and deaths). Fear is strongly influenced by cultural and religious reinforcement, and generalized expectations (Davey 1995).

Different factors affect which animals are socially acceptable and which are considered worthy of protection. To plan environmental education programs focused on snake conservation, it is essential to first examine attitudes towards these animals (Bjerke, Odegardstuen and Kaltenborn 1998; Prokop, Özel and Uşak 2009), instead of relying on the unverified assumption that snakes necessarily evoke fear (Christoffel 2007; Prokop, Özel and Uşak 2009). Almost no studies have investigated children's appreciation of snakes over a large scale (more than one country), and more surprisingly most have ignored the central question of biological knowledge about snakes (Burghardt et al. 2009). Thus, some major questions revolving around the relationship between perceptions of snakes and willingness to protect them remain unanswered.

We used a questionnaire to investigate schoolchildren's (7–14 years old) perceptions of snakes. We focused on contrasted attitudes such as likeability, fear, and willingness to protect snakes, but we also investigated knowledge of snake biology. We addressed four main questions:

- 1) What is the proportion of children who like or dislike snakes?
- 2) What are the broad correlates of snake (dis-)likeability?
- 3) What is the level of biological knowledge of schoolchildren about snakes?
- 4) Is there a relationship between schoolchildren's perception of snakes and their willingness to protect (or harm) them?

Methods

Participants

The survey was conducted from 2007 to 2009 in 10 countries from three continents (Africa [1], Asia [2], Europe [7]), in order to cover a wide range of geographical and cultural situations. A total of 2,570 responses were received, and the mean age of the children was 10 years (range: 7–14 years). The sample sizes (girls + boys + undetermined, labeled G/B/U) were: 227 G/270 B/59 U (France); 142G/128B/2U (Hungary); 45G/53B (Italy); 127G/115B/15 U (Morocco); 10G/22B/9U (Nepal); 27G/32B (Portugal); 163G/132B (Serbia), 80G/79B/1U (Slovakia), 225G/286B/2U (Spain); 153G/178B/6U (Turkey).

Questionnaire

We developed a questionnaire based on preliminary tests (Ballouard 2005) and under the supervision of a committee that included one teacher specialized in child psychology (Ballouard, Brischoux and Bonnet 2011). The questionnaire was translated into nine different languages and was checked by primary school teachers in each country. Using the network of collaborators (see authors list), 96 classes were selected both in urban (city > 30,000 inhabitants) and rural schools (village < 2,000 inhabitants). The questionnaire was tested prior to this study and showed children's answers to be reliable (unpublished). For the current study, we focused on a subset of items related only to snakes. We were interested in the following issues:

- 1) Broad perception of snakes: we asked the children if they liked, or disliked snakes. Then, the children had to briefly explain why.
- 2) Influence of previous experience with snakes: we asked the children if they had ever seen or handled a snake.
- 3) Taxonomic knowledge: we asked the children to list all the species they knew.
- 4) Willingness to protect snakes: we asked the children if they considered it necessary to protect snakes.
- 5) Behavior when facing a snake: we asked the children if they would kill a snake if they encountered one.

A number of questions were closed-ended (e.g., "Do you like snakes?"), with response options of "Yes," "No," or "It depends." Other questions were open-ended (e.g., "Why do you like snakes?") and sometimes generated longer, more complex answers. Consequently, to perform the analyses we classified these complex responses into six broad categories:

- 1) Affectivity: children clearly introduced an affective factor, for example, using terms such as “Because they are cute.”
- 2) Aspect and Behavior: when the physical aspect of the snakes was predominant. Words related to color, size, feel (temperature, “sliminess”), and behavior (crawling) were the criteria used.
- 3) Danger: this category was established for the use of terms such as “They are venomous,” “Dangerous,” “They can bite.”
- 4) Fear: terms such as “I am afraid,” or “I panic” were used in this category.
- 5) Naturalist Interest: children employed terms related to the importance of snakes for science or ecosystems, for example, “They are interesting,” “They are useful.”
- 6) Others: this category includes some answers not easily classified using the criteria above, or belonging to other poorly represented categories (e.g., patrimonial, moralistic). For example, answers such as “It is not a pet,” “I don’t know,” and “They are living animals” were pooled into this category.

For the responses regarding biological knowledge, snake species named by the children were classified into three broad taxonomic levels: 1) Species (e.g., King cobra), 2) Genus or family (e.g., cobra), 3) Larger groups (e.g., water snakes). We faced several difficulties in the classification of some responses, for example, the French name “couleuvre à collier” is “grass snake” in English, which designates a species in French (*Natrix natrix*) but a wider group of species in English; the French equivalent for “grass snakes” is “couleuvres.” In practice, including or ignoring such complications did not change our main results. Responses that were unreadable ($n = 22$), wrong (e.g., “Iguana ...”, $n = 129$), or too imprecise (e.g., “long snakes ...”, $n = 99$) were excluded from the analysis.

Analyses

Data were analyzed using multiple logistic regression (Allison 1999). Initially, all the independent variables were included in the model. A final minimum adequate model was obtained by backward elimination of non-significant ($p > 0.05$) variables. To analyze questions which had two possible answers (e.g., “Yes,” “No,” or “I kill it,” “I do not kill it”) we used a binomial distribution for the dependent variable. To analyze questions which had three possible answers (e.g., “Yes,” “No,” “It depends”), we used a logit link function for the dependent variable. Gender, age, country, experience with snakes (visual and physical), fear, likeability, or the fact that children declared their desire to protect snakes, for example, were all treated as independent variables in the model. Because the age of the schoolchildren had no effect in all the tests performed, we did not conduct further analyses with this parameter. Similarly, we did not include all available additional information, to avoid over-complex analyses (e.g., both rural and urban schools were not sampled in all countries, precluding tests of this factor). A small proportion of the questionnaires (5%) were incomplete, generating minor fluctuations in the sample sizes depending upon the question addressed. Computations were performed with SAS package 9.2.5 (SAS Institute Inc.) and Statistica 7.1 (StatSoft).

Ethics

The questionnaire was produced conjointly with (and approved by) schoolteachers and teachers specialized in child psychology. The parents of the schoolchildren were all aware of

Table 1. Main statistics (GLM analyses) showing the influence of various factors (only significant ones are reported) on the responses to the main questions assessed.

Main Question Assessed	Factor(s)	df	Wald χ^2	p
Do you like (or dislike) snakes?	Country	18	115.0641	< 0.0001
	Sex	2	26.8781	< 0.0001
	Touched*	2	54.9471	< 0.0001
	Fear	2	123.2230	< 0.0001
Explain briefly why	Country	36	54.23654	< 0.0001
Fear level	Country	9	47.9458	< 0.0001
	Sex	1	56.6723	< 0.0001
	Touched	1	16.3008	< 0.0001
	Country \times Touched	9	56.4848	< 0.0001
Is it necessary to protect snakes?	Country	9	68.0939	< 0.0001
	Touched	1	5.7893	0.0161
	Fear	1	5.4452	0.0196
	Like	2	42.0997	< 0.0001
Would you kill a snake in case of an encounter?	Country	9	154.1890	< 0.0001
	Sex	1	9.2431	0.0024
	Fear	1	14.5743	0.0001
	Like	2	21.8289	< 0.0001

*Refers to whether or not the child had ever seen or handled a snake.

our survey and our objectives, which were clearly explained by the teachers. All the responding children consented to complete the questionnaire, and their responses were anonymous.

Results

Likeability of Snakes

A total of 2,497 responses enabled us to explore correlates of snake likeability: 949 children declared that they liked snakes, 961 declared that they disliked snakes, and 587 were undecided. Multiple logistic regression analyses revealed that four parameters had a strong effect on the likeability of snakes: fear, previous physical contact with snakes, gender, and country (Table 1). As expected in each country surveyed, analyses showed a strong effect of children's fear of snakes on the probability to declare an aversion to reptiles or not (Table 1; Figure 1; the data for the 587 children who were indecisive about whether they liked snakes or not were excluded from this analysis). We also observed large inter-country variation in the proportion of children claiming to like snakes: from 12% in Nepal to 53% in Spain.

Why Do Children Like Snakes?

Schoolchildren explained their liking for snakes using predominantly positive affective terms, then they referred to the physical aspect and behavior of the snakes, followed by naturalistic considerations (Figure 2; the answers which were not easily classified or poorly represented were not retained). Although some answers included the "danger" factor, the "aspect" and "affectivity" factors were the most common. A closer inspection of the data revealed differences among countries (Figure 2). In Spain, Italy, Turkey, Hungary, and Nepal, the aspect and the

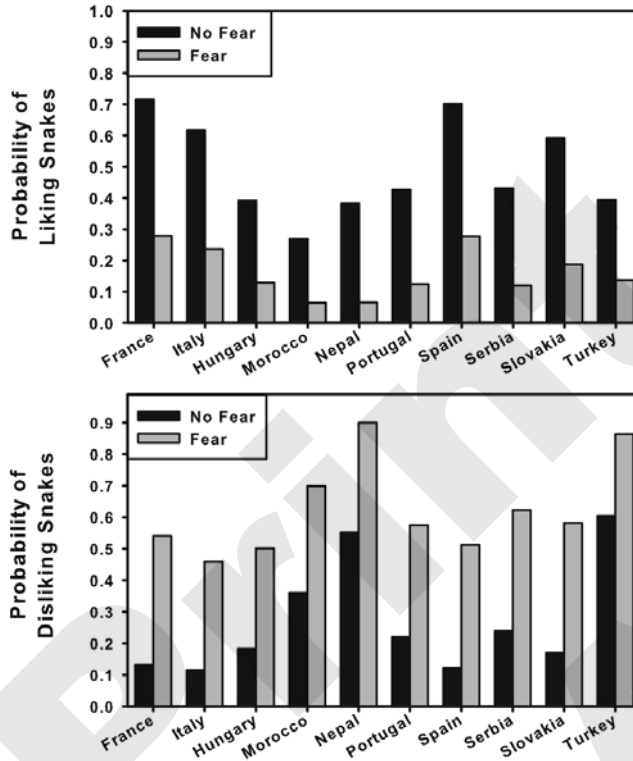


Figure 1. Probability of the children in each of the countries studied declaring that they like ($n = 949$, top graph) or dislike snakes ($n = 961$, bottom graph), based on whether they feared or did not fear snakes.

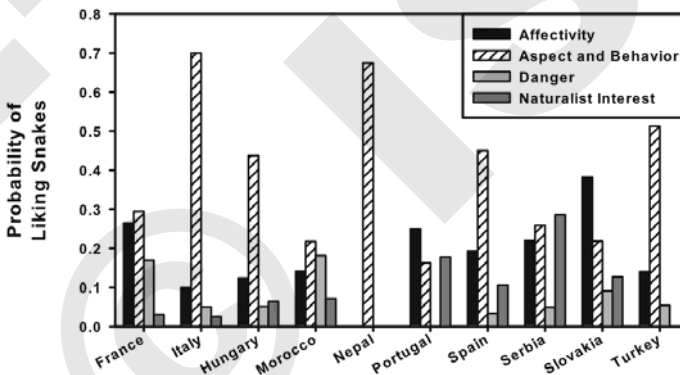


Figure 2. Probability of the children in each of the countries studied declaring that they like snakes ($n = 949$), based on the categories of responses they gave to justify why (see text for details).

behavior of the snakes were the elements most associated with the likeability of snakes. In Slovakia, France, and Portugal, children explained their response using predominantly affective terms. In Serbia, children mainly employed naturalistic terms.

Table 2. Proportion (%) of the children's responses ($n = 961$) to the question "Why do you dislike snakes" containing terms classified into one of six categories (danger, affectivity, snake aspect and behavior, fear, naturalist interest, and other). Proportions above 10% are indicated in bold.

Category	France	Hungary	Italy	Morocco	Nepal	Portugal	Serbia	Slovakia	Spain	Turkey
Danger	41	28	33	62	90	38	49	22	43	52
Affectivity	9	5	3	10	3	8	2	3	2	7
Aspect and Behavior	23	39	37	7	0	21	30	43	21	9
Fear	13	20	13	4	3	25	15	15	29	16
Naturalist Interest	0	0	0	1	0	0	0	0	1	0
Other	5	1	3	16	3	8	0	6	3	15

Note: The sum of the percentages do not always equal 100% (range 89–100%) due to some responses being impossible to decipher, and/or not easily categorized.

Why Do Children Dislike Snakes?

The independent variables, or combinations of them, did not produce consistent simple effects in the multiple logistic regression analyses. In other words, no clear pattern emerged from these analyses explaining why children declared to dislike snakes (Table 2). However, examining the broad combinations of individual responses, we found that children who declared they disliked snakes ($n = 961$) associated this answer mainly with dangerousness (45.2% on average, range 22–90% between countries), with snake appearance (22% on average, range 7–39%), and fear (13% on average, range 3–29%). We observed some important differences between countries. Notably, dangerousness was prevalent in Nepal (90%), Morocco (62%), and Turkey (52%). Fear was prevalent in occidental countries (ranging from 13 to 29%), but was rarely a reason for disliking snakes in Nepal or Morocco (4% and 3%, respectively).

Correlates of Children's Fear of Snakes

Previous physical contact, gender, and country had an effect on whether children declared they were afraid or unafraid of snakes (Table 1). Fear of snakes was lower for children who had previously handled a snake (Figure 3). Girls declared greater fear of snakes than did boys, even those who had previous physical contact with them. However, great variation was observed among countries: only 22% of children in Turkey were afraid of snakes, while in Nepal 83% of children were afraid of them. Interestingly, multiple logistic regressions suggested an interaction between countries and previous physical contact (Table 1). Children who had never handled a snake in Slovakia, Hungary, and Turkey expressed the lowest level of fear, whilst the reverse was observed in France, Italy, Hungary, Spain, and Slovakia, where previous handling was associated with a low level of fear.

Taxonomic Knowledge

Most of the children were able to provide snake names at various taxonomic levels (only 226 children could not), and 4,722 responses were collected. After having removed ambiguous answers (e.g., mixing different species) we retained 4,487 responses for the analyses. Disregarding taxonomic and zoological accuracy, 66 different types of snakes were cited. A small number of snake types (10 snakes with more than 100 occurrences),

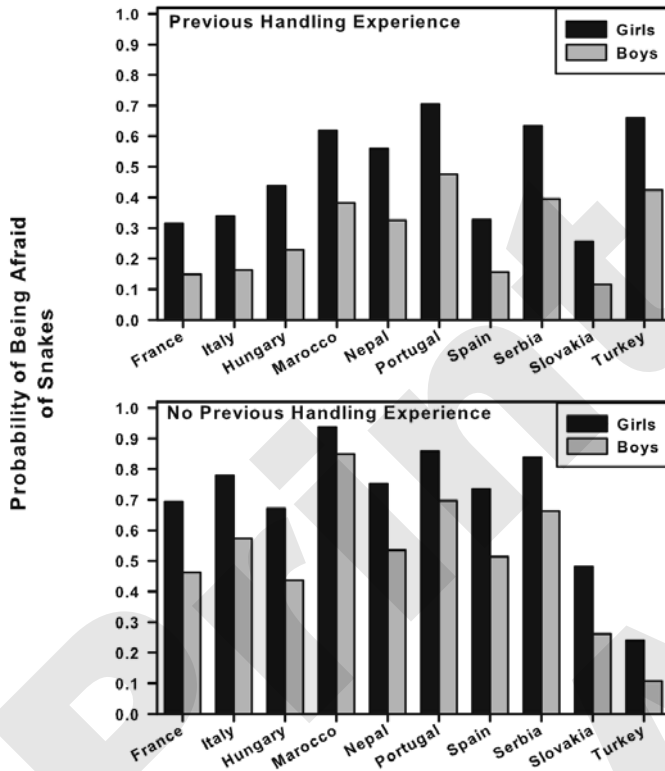


Figure 3. Probability of the children in each of the countries studied declaring that they are afraid of snakes, based on previous handling experience and gender.

corresponding to the most popular snakes (e.g., cobras, vipers, boas), represented more than 90% of the responses (cobra $n = 617$, 14%; viper $n = 600$, 13%; rattlesnake $n = 559$, 12%; python $n = 479$, 11%; “Colubrid” $n = 345$, 8%; boa $n = 314$, 7%; grass snake $n = 265$, 6%), and only 21% were named at the species level (e.g., anaconda, $n = 500$, 11%; king cobra, $n = 315$, 7%; and nose-horned snake $n = 121$, 3%). Considering other snake types (10% of the responses), 32% were cited at a crude taxonomic level (e.g., family). Considering all the responses, 34 snake types were named at the species level, but most of them (22, 6%) were cited fewer than five times. A significant proportion of the children (27%) cited snake types that do not occur in their country; they likely observed these through the media (e.g., anaconda). Overall, children exhibited a limited taxonomic and naturalistic knowledge of snakes.

Willingness to Protect Snakes

In most countries, the proportion of children who believed in the importance of protecting snakes was high, ranging from 56 to 85%. In two countries, Nepal and Morocco, the majority of the children considered protecting snakes to not be important: 59% and 63%, respectively. The willingness to protect snakes was also influenced by likeability (as expected, those children who liked snakes, along with undecided children, generally wanted to protect them); but gender had no influence (Figure 4).

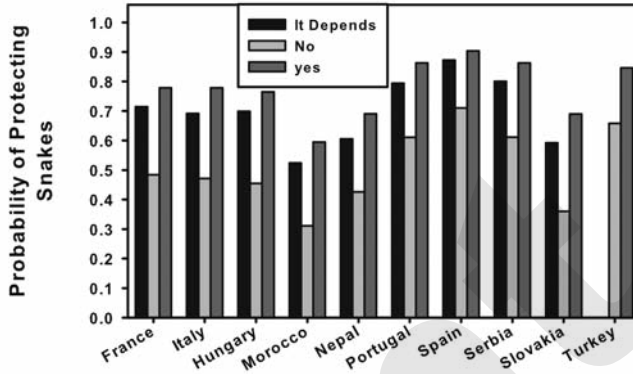


Figure 4. Probability of the children in each of the countries studied declaring that it is important to protect snakes, based on whether or not the children liked snakes.

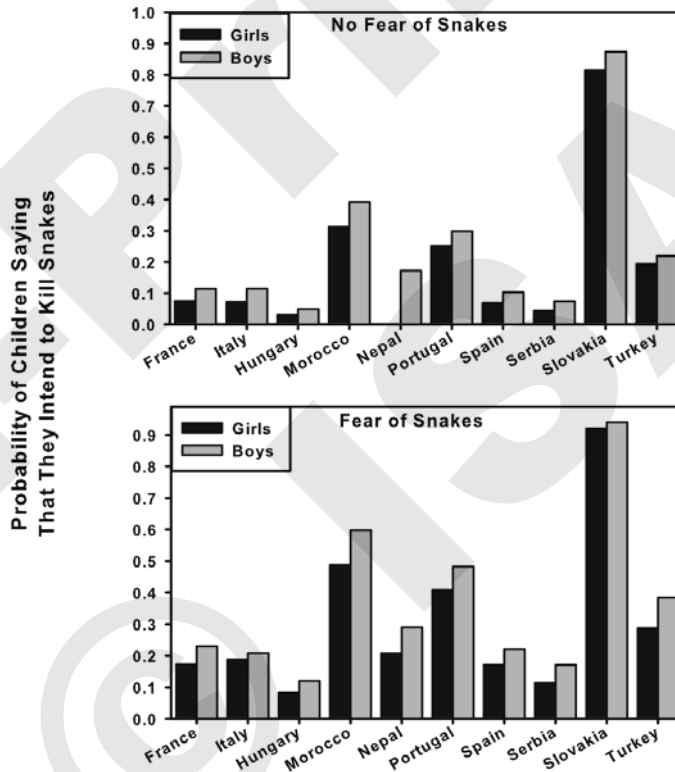


Figure 5. Probability of the children in each of the countries studied declaring that they intend to kill snakes, based on gender and fear of snakes.

Destructive Behaviors

In six countries, the proportion of children that declared they would kill a snake if they encountered one was particularly low (ranging between 7 and 13%); this proportion remained relatively low in Turkey (29%). The three countries where the greatest number of children declared their intention to kill snakes were Morocco (45%), Portugal (60%), and Slovakia (90%). Across countries, boys declared more often their intention to kill snakes, compared with girls (Figure 5). In all countries, fear of snakes was significantly associated with the propensity to kill them.

Discussion

Gauging children's likeability of animal species provides an indirect but crucial way to better understand taxonomic bias in interest in wildlife (Czech, Krausman and Borkhataria 1998; Tisdell, Wilson and Nantha 2006; Stokes 2007; Knight 2008). Broadly, we base our reasoning on the fact that if children like an animal species, they will be more prone to protect it; or at least, that a reduction of dis-likeability is important for educational and associated conservation purposes. Considering the recurrent—but unverified—assumption that humans express a genetically coded fear of snakes and consequently tend to dislike them (Öhman and Mineka 2001; Öhman and Mineka 2003; Isbell 2006; Marešová, Antonín and Frynta 2009), it is crucial to measure how children perceive snakes, and if fear automatically translates into negative, destructive attitudes. Our results negate the simplistic view that snakes are almost always perceived as frightening animals, and that as a consequence they should be destroyed. Instead we gathered a more positive, albeit complex, picture of children's attitudes. Importantly, in this study, we avoided asking the children to rank snakes amongst a set of charismatic animals (e.g., bears, cats). Indeed, this would have automatically suggested that children do not like snakes, although the appropriate interpretation should be that they prefer other loveable animals (Gomez, Larsen and Walton 2004). We emphasize that our investigation was more direct than previous ones in assessing how children perceive snakes per se, and not how they rank them in a list of animals (e.g., panda versus viper; Morris and Morris 1965). Our approach thus avoided a classic analytic trap that consists of directly comparing hardly comparable items.

Do Children Like or Dislike Snakes?

Our results show that an aversion to snakes among children is not an overwhelming attitude. Although 38% of the children declared that they did not like snakes, 38% liked them, and 24% were undecided. In some countries, most of the children spontaneously declared that they liked snakes, while the opposite was observed in other countries (Figure 1). In France for instance, only 25% of the children declared that they disliked snakes. Interestingly, about 50% of adults questioned in France declared that they disliked snakes ($n = 112$ adults questioned during the same time periods and at the same location as the children; unpublished data). This contrast suggests a generational effect, likely due to the shift in attitudes and knowledge over recent decades: snake killing was encouraged in the past (until the 1970s), but the reverse applies now and children are educated to respect all forms of life in most countries (but not all). This also suggests that cultural factors are more important than putative genetic ones. In support of this, Morris and Morris (1965) proposed that fear of snakes is essentially learned through (often unconscious) symbolization and negative education. Whatever the explanation (further investigations are required); the fact that only 38% of the children declared that they did not like snakes was unexpected given the strong, negative publicity given to reptiles in

virtually all media. Disregarding films and video games (where snakes are represented as evil and monsters), we note that even wildlife documentaries usually present snakes as aggressive and dangerous animals (e.g., highly venomous, or large, deadly constrictors).

Factors Influencing Snake Likeability

Affective terms were often provided by children who declared that they liked snakes. Because positive emotions are essential to obtain public support for species conservation (Knight 2008), it is important to redress the negative image of snakes, which has largely been spread through rumors and the media (Brito, Rebelo and Crespo 2004). Most notably, snakes are not cold, slimy or malicious; most are harmless to humans. Of course, great caution should apply in order to not diminish the prudence required against dangerous species (Kasturiratne et al. 2008). Interestingly, in occidental countries, children often referred to incorrect attributes ("sliminess," coldness) to justify their dislike of snakes, but this was not observed in African and Asian countries. This further suggests the crucial role of culture in perception and attitudes toward snakes.

Our results confirm that fear and dangerousness are key elements in explaining why a number of children do not like snakes (Christoffel 2007). We found differences among countries, probably due to poly-factorial and cultural factors (Kellert and Westervelt 1984; Bjerke, Odegardstuen and Kaltenborn 1998; Arrindel 2000; Kaltenborn et al. 2006). Likeability was highest in Western Europe (Spain, Italy, France), where venomous snakes cause few (virtually none) health problems (Sharma et al. 2004; Kasturiratne et al. 2008); snake-bite risk and access to appropriate medical care are thus probably important. Similarly, spiders are perceived more positively by students in areas with a lower number of species harmful to humans (Prokop et al. 2010). Although perception of a danger likely leads to a fear, we also observed that the aversion to snakes was not always associated with the perception of danger. In countries where venomous snakes cause fatal accidents on a regular basis (Morocco, Nepal), snake aversion was mainly explained by perceived real danger, but rarely by irrational fear (e.g., panic in the children's responses). In occidental countries where the risk of getting bitten is very low and the risk of fatality is virtually nonexistent, fear was nonetheless a major element relatively independent of perceived danger (i.e., low prevalence of an association between fear and danger in the responses). This suggests that fear can also emerge independently from risk, and that strong and persistent fear can be irrational and/or influenced by media or strong religious beliefs (Öhman and Mineka 2003). Although this latter issue is probably important to better unravel the causes of people's attitudes toward snakes (e.g., considering the contrasting symbolic use of the snake in the Christian religion and Buddhism), it is outside the focus of the current study.

The inclination of children to engage with, and interact in favor of, the natural environment greatly depends on the emotions they feel during experiences (Kellert 2002). Previous physical contact with snakes was associated with positive attitudes to snakes, but we cannot infer causality from this. Perhaps those children who already liked snakes were also tempted to handle them, generating a circular effect between likeability and physical contact. However, the independent variable "Observed but never handled" was not retained in our analyses, suggesting that visual contact alone was not essential. In support of our interpretation, Prokop and Tunnicliffe (2008) observed that manipulating animals in the wild decreased irrational aversion to frightening animals. In addition, previous experimental work provides further support for the notion that physical contact with snakes increases positive

attitudes toward them (Morgan and Gramann 1989). Overall, the available information suggests that snake handling improves children's perception of snakes, and this is likely mediated through an emotional response generated by the physical contact (Ballouard et al. 2012). In addition, children realize that snakes captured in the wild are often hot and soft, rarely cold, and never slimy.

Gender is perhaps one of the most important and consistent variables affecting attitudes towards animals (Morris and Morris 1965; Arrindel et al. 2000; Kaltenborn et al. 2006; Prokop, Özel and Uşak 2009; Prokop and Tunnicliffe 2010). Although girls usually declare more sympathy and respect for animals (Kellert and Westervelt 1984), we found less clear patterns with snakes (Prokop, Özel and Uşak 2009). The boys who declared that they were not afraid of snakes were also more likely to declare that they would kill them. This negative association was not expected. We suggest that this may rather reflect the influence of different sex roles (Kaplan 1996): males are expected to confront more easily their predators (Hawkes, O'Connell and Blurton Jones 1991), whilst females are expected to prefer escape strategies (Coss and Moore 2002). This issue requires further investigation.

Taxonomic Knowledge

Knowledge of organisms is a key component to better understanding and protecting biodiversity (Wilson and Tisdell 2005). The capacity to name animals corresponds to the most basic level of knowledge. Previous studies showed that snakes are poorly known, often mixed with amphibians or even invertebrates (Yen, Yao and Mintzes 2004; Kubiak and Prokop 2007). Our results are convergent: knowledge was limited to a few charismatic snakes, mostly large, spectacular, and exotic snake types, and the children were generally unable to provide precise species names. The high level of reference to cobras and vipers might be driven by the media and spread by rumors (Burghart et al. 2009). Further analyses to examine if, as expected, cobras are more often cited in Nepal compared with Turkey, for instance, will not alter the main outcome of our study: children's taxonomic and naturalistic knowledge of snakes was very poor, even in countries where different species can be easily observed. Clearly, progress is required to improve children's knowledge of animals (Ballouard, Brischoux and Bonnet 2011; Ballouard et al. 2012).

Conclusions

This study is the first to directly explore children's perceptions of snakes across different geographic, and thus cultural, zones. Considering the complexity of this topic (owing to the interactions between gender, age, culture, religion, geography, etc), we focused here on a major conservation issue. We investigated the relationships between likeability and the willingness of young schoolchildren to protect non-iconic, and supposedly much disliked, animals: snakes.

Our results revealed several unexpected patterns. The proportion of children claiming that they like snakes, and that it is important to protect them, was high considering the well-established belief that snakes are unpopular animals. This suggests that adults (including researchers) should not project their own negative perceptions about snakes onto children (e.g., Öhman and Mineka 2003; Isbell 2006; Marešová, Krasa and Frynta 2009) but should question the children. Our results also showed that most children were reluctant to kill snakes. This attitude is in strong contrast to what is observed in adults: the level of persecution of snakes, including non-venomous species, is extremely high in many countries and essentially achieved by adults (Greene 1997; Knight 2008; Fita, Costa Neto and Schiavetti 2010).

Several encouraging messages emerged from our analyses. Despite a relatively low level of knowledge, we found a high level of willingness to protect snakes; and more importantly, the level of aversion was superior to the declared propensity to kill snakes. Thus, fear did not necessarily translate into destruction.

Overall, by focusing on supposedly unpopular animals, this study has shown that it is not necessary to use charismatic animals to convince children to protect wildlife. Environmental education should not neglect animals declared as unpopular by adults; significant efforts must be made to not limit conservation messages and actions to a handful of iconic species. Contact with animals may be one of the best tools to promote positive attitudes (Ballouard et al. 2012). Children should be brought into the field, in close contact with wildlife, to appreciate and respect all living forms, including snakes (Erdogan et al. 2008; Lindemann-Matthies and Bose 2008).

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