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RESEARCH ARTICLE

# Is Popularity a Double-Edged Sword? Children Want to Protect but Also Harvest Tortoises

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**ABSTRACT**

The likeability of organisms is an effective tool for conservation education. However, stimulating the cute appeal of animals can also bolster the desire to possess them, and thus can encourage the trade in animals as pets. We assessed the perception of primary French schoolchildren (7–11 years old) for the Hermann tortoise (*Testudo hermanni*), a popular species endangered by illegal harvesting. Likeability for tortoises is associated with a strong willingness to protect them. Many children, however, expressed controversial attitudes toward them, such as the desire to possess a tortoise as a pet and to remove it from its natural habitat. Likeability was a significant determinant of these attitudes, and must thus be used with caution. Implementing these findings in conservation education programs should, therefore, be considered.

## Introduction

### Paradoxical effect of species popularity

Loveable, popular and appealing species attract more support than less popular ones for which aversion or fear represent strong obstacles for their conservation (Ballouard, Brischoux & Bonnet, 2011; Ballouard et al., 2013; Kellert, 1993; Prokop & Tunnicliffe, 2008; Schlegel & Rupf, 2010). Therefore, strengthening or identifying the level of empathy for targeted species is considered as an efficient method in Environmental Education (Bowen-Jones & Entwistle, 2002). Enhancing the likeability of organisms may induce undesirable effects however. The immense success of the movie *Finding Nemo* prompted sudden shifts in popularity levels, followed by an increase of the demand for domestic clownfish that were extracted from their natural habitat (Yong, Fam, & Lum, 2011). More generally, by reinforcing the cute appeal of animals, media or campaigns may enhance the desire to possess pets and involuntarily distort the public's perception to protect wild species (Moorhouse, Balaskas, D'Cruze, & Macdonald, 2017; Nijman & Nekaris, 2017; Schroepfer, Rosati, Chartrand, & Hare, 2011). An excess of emotional response can generate paradoxical conservation effects and cancel the initial educational benefits intended (Yong et al., 2011). While the validity of these negative side effects is strongly debated (Militz, & Foale, 2017), clarifying these divergences is important to amend educational practices. We may predict a positive correlation between attractiveness and the willingness to collect individuals. Consequently, during outreach activities that promote a positive image of living organisms (plants or animals), is it important to emphasize that they should not be removed from their natural habitat?

### *Research question*

Our research question was precisely oriented to examine to what extent the likeability of a threatened animal species, the Hermann tortoise, may generate paradoxical conservation effects. Because pets represent the main bond between children and animals, and because the pet trade is largely influenced by the demands of children (Nijman & Nekaris, 2017), we need to question children to try to establish associations between likeability, ecological knowledge, the willingness to protect wild animals, and trends in considering them as possible pets. The Hermann tortoise *(Testudo hermanni, Gmelin, 1789) is* exposed to multiple threats in Europe (Nikolic et al., 2018). Populations of both western (*T. h. hermanni*) and eastern subspecies (*T. h. boettgerri*) are fading throughout their geographic range. The situation of the western subspecies is particularly worrying. Previously abundant throughout a large part of the Mediterranean area from Italy to Spain, loss of habitat, and over-harvesting resulted in strongly fragmented and reduced populations (Bertolero, Cheylan, Hailey, Livoreil, & Willemsen, 2011).This species is now classified in the IUCN Red List of Threatened species (IUCN, 2013). In continental France, only one population located in and nearby the Maures Mountains (Var district, South east) persists. Population viability analyses further suggest that even remaining populations inhabiting favorable environments could face extinction due to over-harvesting in a matter of years (Nikolic et al., 2018). In France, the Hermann tortoise persists in densely populated areas, and, since, adult life is long (>30 years, Bertolero et al., 2011), the probability of tortoises encountering humans is high.

### *Context of the Study*

The Hermann tortoise, often viewed as a potential domestic companion by the public, is strongly exposed to the paradoxical effects of its excessive popularity, and thus it represents a suitable organism for our investigation. Among wild animals, chelonians are commonly adopted as pets, both through legal and illegal markets (Bush, Baker, & Macdonald, 2014; Luiselli, Starita, Carpaneto, Segniagbeto, & Amori, 2016; Prokop & Tunniclife, 2010). The intensity of the tortoise trade causes irremediable damage to tortoise populations and can even push species to extinction (Ljubisavljevic, Dzukic, & Kalezić, 2011; Luiselli et al., 2016; Tujrkozan, Ozdemir, & Kiremit, 2008). Tortoises are easy to harvest and to dispatch through the pet trade; populations are highly sensitive to overharvesting. On the other hand, tortoises are probably the reptiles the most often depicted with positive images or represented as popular mascots (Tisdell, 2010). Overall, wild tortoises provide a fine sample to examine to what extent positive emotional responses can generate undesired attitudes. Evaluating how education messages should be crafted to ameliorate conservation education is thus essential, notably to reduce consumer demand for tortoises as pets (Moorhouse et al., 2017).

This study, conducted in the Var district of southern France, aims to assess the perception of primary schoolchildren (7–11 years old) for the endangered Hermann tortoise (*Testudo hermanni hermanni*) (Livoreil, 2009; Van Dijk, Corti, Mellado, & Cheylan, 2004). It is framed within a global educational campaign of a European Life conservation program (LIFE08NAT/F/000475 2010-2014) devoted to the Hermann tortoise. Children were targeted because they are more receptive than adults to environmental messages (Jacobson & McDuff, 1998), they are less likely to display destructive behavior (i.e., poaching), and they can significantly influence the attitude of their parents (Damerell, Howe, & Milner-Gulland, 2013). Further, children are particularly receptive to emotional learning, especially when animals are involved (Kellert, 1985; Louv, 2005).

We hypothesized that schoolchildren would express a high level of likeability for tortoises associated with a strong willingness to protect them. We also evaluated their general knowledge about the Hermann tortoise and their natural habitat. Then, since emotional factors may overwhelm rational attitudes; we also examined to what extent children expressed the desire to possess a tortoise as a pet. Finally, we assessed the knowledge level of the children regarding the threats faced by tortoises. To investigate these issues, we used individual responses obtained through a large survey (>1.000 respondents).

## Methods

### *Study site and participants*

The survey was conducted from 2012 to 2014 in the southeast of France, in a district (Var) that largely covers the geographical range of the Hermann tortoise (Livoreil, 2009). A total of 1,545 schoolchildren from 21 different schools completed a printed survey. A small proportion of the questions (<8%) remained incomplete, generating minor fluctuations in the sample size depending on the question asked. The schools were located in both urban and peri-urban areas. The age of the children ranged from 7 and 11 and averaged at $8.99 \pm 1.20$ ($\pm$SD, N = 1,527) (Table 1). The gender ratio was a balanced one (49% girls, N = 1,545). Following questionnaire completion, schoolchildren were involved in the tortoise education campaign (classroom activities, visits to tortoise rescue center or field trip excursions).

### *Questionnaire*

The questionnaire was made up of 12 questions (Q) organized into six categories (Table 2). These categories correspond to several broad types of attitudes used to assess the possible impact of likeability on the perception of the tortoises, and on the willingness of children to have them as pets. We also investigated the level of knowledge of the respondents. Precisions about the six categories (and the twelve questions they contain) are provided below:

1. *Level of likeability:* we asked the children to rank their own likeability level for tortoises using a simple scale (5 increasing levels, Q1). We also asked the children to sort 10 animals from a list by preference (10 was the highest score, Q2). The list included popular (e.g., dolphin) and less popular animals (e.g., fish): beetle; dog; dolphin; eagle; fish; fox; polar bear; snake; tiger, tortoise. To characterize likeability, we also used a simpler code (Y/I/N [I means indeterminate], Table 2) to limit the distortion of the results.
2. *Willingness to protect tortoises:* we asked the children to sort 10 animals from a list by conservation priority (10 was the highest score, Q3, the same list of animals than above). We also asked the children if they considered it necessary to protect the tortoises (Q4).
3. *Knowledge about the Hermann tortoise:* we asked the children to give the name of the tortoise represented in a Colored picture (i.e., Hermann tortoise, Q5). Then we asked them if this species is endangered (Q6). We then asked them to list the main threats (Q7). The response to each question (Q5-Q7) was associated to different scores (details in Table 2); we used the sum of the scores (Q5 + Q6 + Q7) to calculate a global knowledge score (ranging from 0 to 4). Responses to Q7 were also classified in 10 categories: predators, accidental death (e.g., collision with cars), deliberate killing, harvesting, fires, habitat destruction (e.g., deforestation, urbanization), pollution, vague (e.g., unidentified human causes, disease), and out of focus responses. We also asked, with an open question, how they would protect tortoise (Q8). We classified the various responses into 13 categories: captivity, non-captivity, translocation, regulation, pollution reduction, care provision, vague response…
4. *Perception of tortoise as a pet:* we asked the children if they consider the tortoise as a wild animal, a pet, or both (Q9). Then we asked them to tick the picture(s) representing an appropriate habitat for the tortoises (Q10); children could tick zero up to six pictures (garden, forest, vineyard,

**Table 1.** Number of participants according to age and gender.

| Age | 7 | 8 | 9 | 10 | 11 | NA | TOTAL |
|---|---|---|---|---|---|---|---|
| Girls | 95 | 177 | 209 | 199 | 72 | 4 | 756 |
| Boys | 88 | 197 | 194 | 212 | 82 | 13 | 786 |
| NA | | 2 | | | | 1 | 3 |
| | 183 | 376 | 403 | 411 | 154 | 18 | 1545 |

**Table 2.** The 12 questions (Qn) were organized into six main categories. A code and/or a score were attributed depending on each question (see text in material and method).

| Category | Question | Option/detail | Code | Scores |
|---|---|---|---|---|
| **Likeability** | Q1. Do you like tortoises? | Not at all | N | 1 |
| | | No | N | 2 |
| | | Indifferent | I | 3 |
| | | Yes | Y | 4 |
| | | Yes a lot | Y | 5 |
| | Q2. Sort the animals from the list by your preference | List provided | | 1 to 10 |
| **Willingness to protect** | Q3. Sort the animals from the list by conservation priority | List provided | | 1 to 10 |
| | Q4. Should tortoises be protected? | Yes | Y | |
| | | No | N | |
| **Knowledge** | Q5. Name the tortoise species pictured | Other | | 0 |
| | | Hermann tortoise | | 1 |
| | Q6. Are tortoises endangered? | No | | 0 |
| | | Possibly | | 0.5 |
| | Q7. List potential threats | No answer | | 0 |
| | | Out of focus | | 0 |
| | | 1 - 2 threats | | 1 |
| | | > 2 threats | | 2 |
| | Q8. How to protect tortoise | Free listing | | |
| **Perception of tortoises as pet** | Q9. A tortoise is: | A pet | P | |
| | | A wild animal | W | |
| | | Both | P | |
| | Q10. Tick the pictures representing the best habitat for tortoises | Garden | Y/N | |
| | | Forest | Y/N | |
| | | Vineyard | Y/N | |
| | | Residential area | Y/N | |
| | | Scrub forest | Y/N | |
| | | Dense scrub forest | Y/N | |
| **Desireability/Willingness to possess a tortoise** | Q11. Do you want a tortoise at home? | Yes | Y | |
| | | No | N | |
| **Attitude in the field** | Q12. What would you do if you found a tortoise in the wild? | Observe & touch | Y/N | |
| | | Observe only | Y/N | |
| | | Ignore | Y/N | |
| | | Call parents to take it | Y/N | |
| | | Bring it home | Y/N | |
| | | Kill it | Y/N | |

      housing complex, scrub forest, dense scrub forest). Ticking a garden suggests that tortoises are potential pet, while ticking dense forest suggests that they are wild animals.
5. *Desirability to take a tortoise as a pet:* we asked the children if they would like to have a tortoise at home (Q11).
6. *Attitude in the field:* we asked the children what they would do if they encountered a wild tortoise in its natural habitat (Q12). Six responses were proposed, ranging from observation and handling to harvesting the tortoise to bring it home. The responses provided information about the level of interest and about a possible decision to harvest the animal. Observing and handling without harvesting a tortoise suggests a strong interest without overwhelming desire for collection. Collecting a tortoise suggests that children are concerned but cannot resist taking it as a pet.

### *Administration procedures*

The surveys were carried out during class time by one evaluator (AJ, MC and NJ). The questionnaire was introduced as a survey, not an exam, to limit the anxiety for the schoolchildren. The evaluator explained to the schoolchildren that the main goal was to assess their perception and knowledge about animals. The children required 15 minutes on average to complete the questionnaire. Children were allowed to ask for clarification. In most cases, individual help was given to children (e.g., help with spelling

a name). Responses to frequent and/or general questions were provided to the class. The legal aspects of the survey were organized within the Life + framework (LIFE08NAT/F/000475).

### Analyses

Proportions of categorical responses provided by the children (e.g., Y/N, Table 2) were analyzed using contingency tables. Continuous variables (e.g., scores ranging from 1 to 10, Table 2) were analyzed using parametric or non-parametric analyses of variance depending upon the distribution of the data. For instance, the distribution of likeability score (1–5) was systematically skewed towards high values, even using Box-Cox transformation for example, whereas the distribution of knowledge scores followed a bell curve. When using parametric tests, we verified that the normal probability plot of the residuals was approximately linear, indicating that the error terms were normally distributed in this analysis. Further, our data set could not contain any outlier. Responses to Q1 (likeability) were used both as a code (e.g., Y/I/N; then implemented as a factor during analyses) or a score (i.e., used as a dependent variable during analyses). Similarly, for conciseness, we split children with a knowledge score inferior to 2 (n = 693, I) from those with a score superior to 2 (n = 610, S) to generate a simple code (I/S, factor) in addition to the score (i.e., used as a dependent variable). Possible interactions between factors (e.g., gender, age, level of likeability code) were performed using a general logistic-regression model (GLM) with binomial distribution of the variables to analyze the perception and attitudes of the children (e.g., willingness to possess tortoise as a pet). Model selection was performed using stepwise (backward) and Akaike Information Criterion ($\delta$AIC > 2, with a preference for the most parsimonious model) (Burnham & Anderson, 2004). We used the lme4 package implemented in the R software and STATISTICA.12 (TIBCO Software Inc., 2018).

## Results

### Likeability

Most children (78%) declared "to like" or "to love" tortoises ($\chi^2 = 250.7$, df = 1, P < 0.001; N = 1,527); girls more frequently than boys (82% for girls, N = 616, *versus* 73%, N = 568 for boys; $\chi^2 = 19.5$, df = 1, P < 0.001). As expected, the mean score of likeability was elevated; it was higher in girls ($4.3 \pm 0.9$, N = 744) compared to boys ($4.1 \pm 1.0$, N = 765) (Kruskal-Wallis Anova: $H_{1, N=1,509} = 9.3$, P = 0.001; Figure 1). It slightly and regularly declined with age (Kruskal-Wallis Anova: $H_{4, N=1,509} = 31.7$, P < 0.001; Figure 1).

Regarding the analysis of the animals sorted by the children's preferences (N = 1,219 complete lists), we observed strong taxonomic differences (contingency table with 10 animal species and 10 possible ranks; $\chi^2 = 5,217.2$, df = 81, P < 0.001); three main patterns were visible (Figure 2). Two species were generally placed at the bottom of the list (the beetle notably and the snake, often ranked 1) and thus were not preferred. Two species were generally placed on the top of the list (often ranked 10), the dolphin and the dog. The other species were generally placed in intermediate position. The tortoise was relatively often highly ranked (Figure 2). The mean preference score was calculated for each species (range $2.6 \pm 2.3$ [beetle] – $7.4 \pm 2.6$ [dolphin]); the mean value obtained for the tortoise ($6.4 \pm 2.6$) was high (in third position after the dolphin and the dog).

### Willingness to protect wildlife

Analyses revealed trends close to those obtained with likeability levels. For example, most children (73%) declared their willingness to protect tortoises ($\chi^2 = 250.7$, df = 1, P < 0.001; N = 1,520); girls more frequently than boys (76% for girls, N = 747, *versus* 71%, N = 773 for boys; $\chi^2 = 4.5$, df = 1, P = 0.033).

Regarding the children's conservation preferences (i.e., sorting from a list of 10 animals), we found strong taxonomic differences ($\chi^2 = 4,668.9$, df = 81, P < 0.001; Figure 2). However, the tortoise was the preferred species (often ranked 10), and was thus considered as a priority in terms of conservation. The
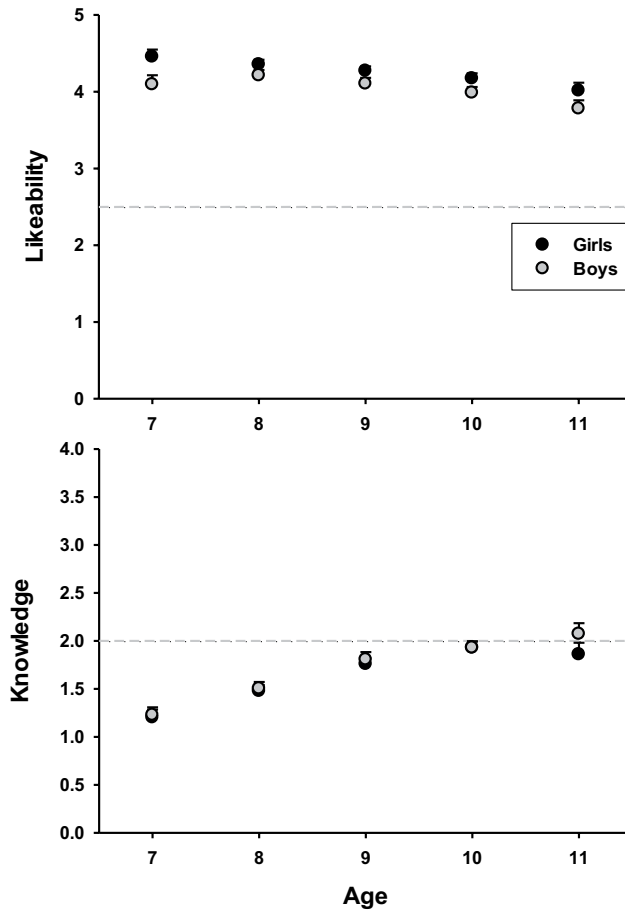
**Figure 1.** Mean score (±SE) of likeability (upper panel) and of knowledge (lower panel) according to age (7–11 years, N per group ranging from 60 to 210) in girls (black circles) and boys (gray circles). See table 2 and text for calculation details. The dashed horizontal gray line indicates the theoretical mean score. Likeability was higher in girls and declined with age (see text for statistics); knowledge did not differ due to gender and increased with age (see text for statistics).

beetle was the only species generally placed at the bottom of the list (rank 1) and the dog was not highly ranked (it was replaced by the bear).

The willingness to protect a species was positively correlated with its likeability score (Figure 3).

### *Knowledge*

The mean global knowledge score was $1.7 \pm 0.89$ (SD) and thus was not elevated considering the maximal possible score of 4 (Figure 1). The knowledge level did not differ due to gender and increased with age (Anova with global knowledge score as the dependent variable, gender and age as the factors, effect of gender $F_{1, 1279} = 1.38$, P = 0.240; effect of age $F_{4, 1279} = 25.62$, P < 0.001; interaction $F_{4, 1279} = 0.39$, P = 0.820; Figure 1).

A minority of children correctly identified the Hermann tortoise from the picture provided (24.5%, N = 1,495; $\chi^2 = 208.2$, df = 1, P < 0.001), only 42% considered this species as endangered, and 43% hesitated about the conservation status (N = 1,480, $\chi^2 = 235.9$, df = 2, P < 0.001). Most of the children (60.2%) correctly cited one or two threats but only 6.4% cited more than two and 33.4% were not able to cite any (N = 1,358, $\chi^2 = 591.1$, df = 2, P < 0.001).

Natural predators represented the most often cited threat (20.2%), collision with vehicles and intentional killing respectively provided 12.7% and 9.7% of the responses. Fire and pollution were cited in
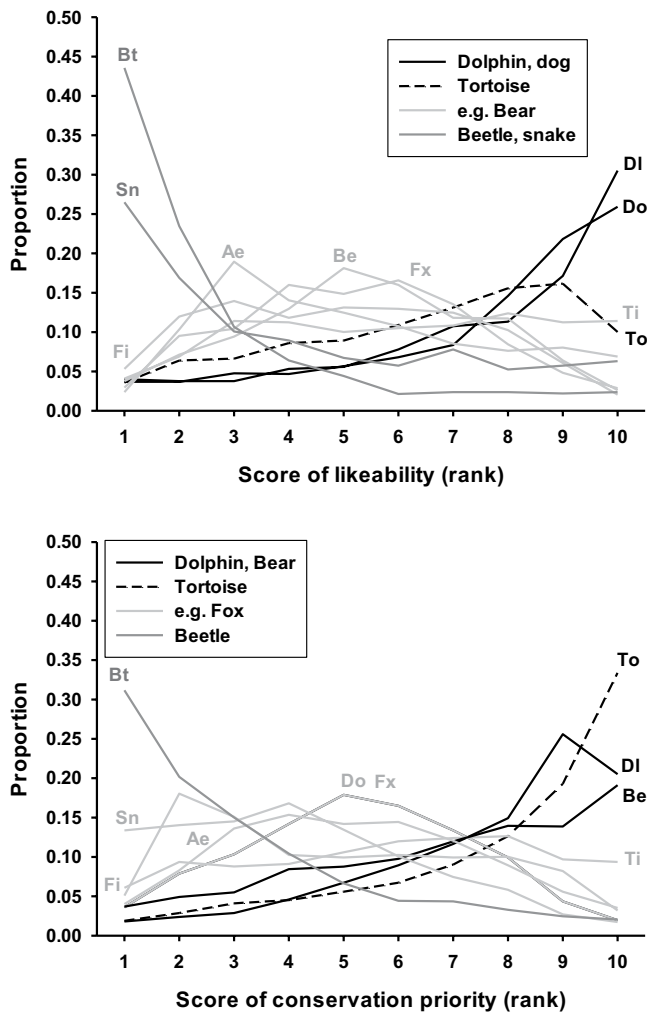
**Figure 2.** Patterns of children's preference for 10 animal species: each line provides the distribution of the sorting procedure for each species. The Y-axis indicates the proportion calculated for each rank (X-axis), from the least preferred (bottom of the list, 1) to the most preferred (top of the list, 10). For each line, the sum of proportions equal to 1. The upper panel provide the results from the sorting of the likeability of 10 animal species; the lower panel provides the results for the conservation priority (see Table2 and text for details). Three main patterns are visible: increasing proportions (black lines) reveal preferred species (often ranked 10); decreasing proportions reveal "not-preferred" species (gray lines, often ranked 1); relatively flat curves indicate species in an intermediate position (light gray lines, generally ranked from 3 to 8). The tortoise line is shown with a dashed line (To). Bt (beetle), Sn (snake), Fi (fish), Ae (eagle), Be (bear), Fx (fox), Dl (dolphin), Do (dog), Ti (tiger).

6.8% and 5.7% of the responses. Habitat destruction represented 3.1%, harvesting 2.4%. Many children could not provide any clear answer (no answer, out of scope, 39.5%).

Backward model selection procedure retained first the effect of age ($F_{1, 1267} = 89.6$, $P < 0.001$) and then of likeability ($F_{4, 1267} = 7.5$, $P < 0.001$) to explain variations of global knowledge score. Interestingly, while most of the children could not cite any way to protect tortoise (43.3%) (Q8), a significant proportion of the children suggested captivity (19.4%) as a way to protect them, legislation was cited 14% of the time, but protection of habitats only in 0.9% of the responses.

### *Perception of tortoise as domestic or wild animal, and of their habitat*

Most children (51.7%) considered tortoises both as a domestic and a wild animal; 26.9% considered it as domestic, 21.2% as wild animal, and two (0.1%; discarded from following analyses) could not answer
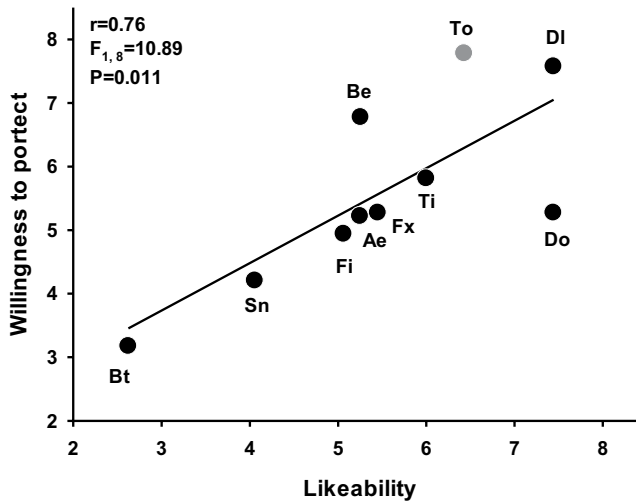
**Figure 3.** Relationship between the willingness to protect a species (mean preference score: mean ranking position from the list of 10 animals) and the associated likeability (mean preference score). The ten species were coded as follows: Bt (beetle), Sn (snake), Fi (fish), Ae (eagle), Fx (fox), Ti (tiger), Do (dog), Be (bear), To (tortoise, gray circle), Dl (dolphin). Note that seven species were close to the regression line while three were not. The dog was highly liked but not considered as a priority for conservation and vice versa for the bear and the tortoise.

(N = 1,508; $\chi^2$ = 814.7, df = 3, P < 0.001). The proportion of children considering tortoises as a pet decreased with age; yet this effect was compensated by an increasing proportion of children who classified the tortoise as both a domestic and a wild animal ($\chi^2$ = 62.6, df = 8, P < 0.001; Figure 4).

GLM analysis revealed that the level of knowledge was the most significant factor on the perception of the children: a greater knowledge was accompanied by a higher probability to consider tortoises as wild animals (Table 3).

The pictures of suitable habitats preferentially selected were those with trees and scrubs (77%), others habitats were less often selected (garden 14%, vineyard 6%, residential area 3%). Fifty-five percent of the children selected exclusively forest/scrub habitats, 6% exclusively the residential area or the garden.

### *Desirability and behaviour*

A high proportion of the children (72.9%) declared their willingness to possess a tortoise at home. This attitude (proportion) slightly decreased with age (N = 1,502, $\chi^2$ = 12.0, df = 4, P = 0.017; Figure 4), and this decrease was positively influenced by the level of likeability (Table 3). The majority of children declared that they would leave a wild tortoise found in the field (65.3%), but a substantial proportion declared that they would take it to bring it home (34.1%). The proportion of children declaring that they would take the tortoise decreased with age (N = 1,421, $\chi^2$ = 16.6, df = 4, P = 0.002; Figure 4), either alone (26%) or with the help of their parents (6%). The level of knowledge was the most important factor explaining variations in this behavior (Table 3).

### Discussion

This study provides both encouraging and worrying results, and, therefore, confirms that promoting the popularity of species for conservation is a technique that must be used with caution. Below, we briefly review our main results and then examine the influence of important factors (e.g., age) that should be considered during educational programs designed to enhance pro-environmental attitude of children.
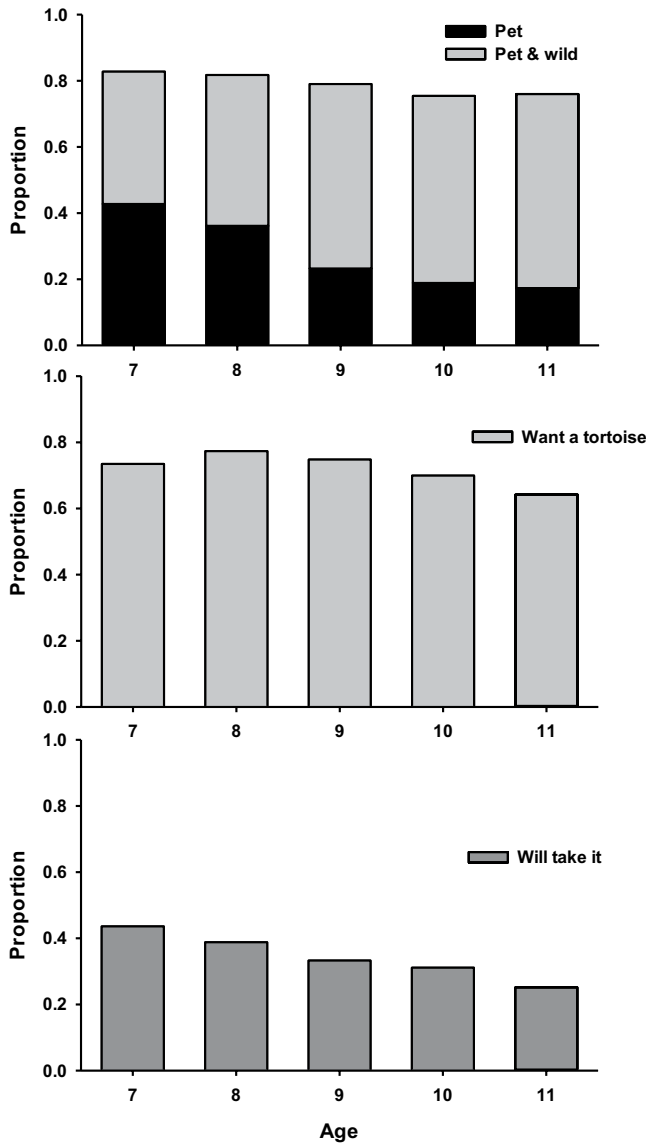
**Figure 4.** Each panel displays the proportion of responses provided by the children: A (top panel) tortoise classified as a domestic animal (pet, black bars), or both as a domestic and wild animal (gray bars); B (medium panel) declarations of the willingness to have a tortoise at home; C (lower panel) declarations of the willingness to take a tortoise from its natural habitat.

### *Well-intentioned children want to harvest loveable animals*

Most children displayed a high level of likeability towards tortoises, and this positive feeling was associated with a strong willingness to protect them. But our results also revealed paradoxical attitudes: many children expressed the desire to possess a tortoise as a pet, and declared that they would harvest one from its natural habitat if they had the opportunity. Likeability was a significant determinant of the willingness to remove tortoises from wild populations, and thus acted as a double-edged sword. These outcomes were supported by significant statistical tests, but, more importantly, the strong coherent effects among the factors examined fit well with the results from other studies on children's attitudes. They also reflect the finding that desirability and affection are prominent traits among pet owners (Kampfer & Love, 1998). Unfortunately, harvesting wild tortoises can have disastrous effects on their population (Williams, 1999).

**Table 3.** Results from a GLM analysis to assess the influence of different factors on the responses to three main questions relative to the perception, attitude and behavior of schoolchildren toward tortoises.

| Main questions assessed | Factor(s) | Df | Wald z-value (intercept) | AIC |
|---|---|---|---|---|
| Perception of the tortoise | **Knowledge** | 1 | 15,121 | 1181,7 |
| | Knowledge*Age | 10 | −2,992 | 1191,5 |
| | Age | 4 | 6,135 | 1214,2 |
| | Gender | 1 | 13,047 | 1216,1 |
| | Likeability | 2 | 3,808 | 1218,6 |
| | Likeability*Age | 10 | 3.832 | 1225,4 |
| Willingness to possess a tortoise at home | **Likeability** | 2 | −3,596 | 1160,3 |
| | Likeability*Age | 14 | 4,4 | 1165,4 |
| | Age | 4 | 5,286 | 1300,8 |
| | Knowledge | 1 | 11,086 | 1302,6 |
| | Gender | 1 | 11,317 | 1302,7 |
| | Knowledge*Age | 10 | 2,773 | 130,6,6 |
| Willingness to take a tortoise home | **Knowledge** | 1 | −4,326 | 1439,4 |
| | Knowledge*Age | 10 | −4,419 | 1442,7 |
| | Age | 4 | −1,607 | 1453,4 |
| | Likeability*Age | 14 | −4,4 | 1452,6 |
| | Likeability | 2 | −3,168 | 1453,8 |
| | Gender | 1 | −6,771 | 1463,6 |

### *Effect of age*

It was not surprising to observe that many children considered that a loveable animal should be taken home. Indeed, we sampled relatively young children, 90% were 10-year-old or less and 10% were 11-year-olds (Table 1); in this age cohort they do not necessarily apprehend the environmental complexity that animals face in their natural habitats (Myers, Saunders, & Garrett, 2004). Accordingly, they typically express strong emotional attachment to individuals with a tendency to anthropomorphism, but they do not identify the global level associated with population viability (Kellert, 1985; Myers et al., 2004). The ability to perceive and understand complex functional links among organisms (e.g., trophic webs, population structures) usually emerge in older children, 11 to 14-year-old (Myers et al., 2004).

Possessing animals (living or stuffed) is a strong cultural element for many children, possibly influenced by spontaneous behaviors (Kampfer & Love, 1998). The strong age effect we observed (43% of 7-year old children considered tortoises as pet, this proportion dropped to 17% in 11-year old ones) has been previously reported (Kellert, 1985, 2002; Myers et al., 2004). Yet, 20% of adults consider tortoises as domestic animals (unpublished results, N = 213 respondents). Our results also show that a significant proportion of the schoolchildren (>30%) would illegally harvest a tortoise (directly or indirectly with the help of parents) from the wild. This worrying attitude decreases with age, albeit persisting in 8.5% of the adults (unpublished data, N = 213 respondents). These elevated proportions, associated with the fact that desirability is a central determinant of the removal of individuals from their natural habitat, indicate that the pet factor represents a serious threat (Bush et al., 2014; Nekaris, Campbell, Coggins, Rode, & Nijman, 2013).

### *Accessibility of desired animals*

Some species are vulnerable to harvesting, but others less or not. While the willingness to possess a pet has probably no consequence for polar bears, it is more worrying for tortoises because they often cohabit with humans, are harmless, slow moving and relatively small, and thus are easily collected. As a result, illegal harvesting and the pet trade are some of the main causes for the decline of tortoise and turtle numbers in the world; in Europe these animals are often offered to children (Williams, 1999). With urban sprawl, tortoises share their habitat with an increasing number of people; their human encounter rate is thus rising (Pérez, Giménez, & Pedreño, 2012).

### Influence of ecological knowledge

Although inappropriate and illegal, many people consider that taking home wild tortoises is a safety measure for the animal found in its natural habitat. Wild tortoises look vulnerable (i.e., slow animals that cannot escape threats), they suffer from predation, building work, and from frequent and destructive forest-fires in Mediterranean regions (Prométhée, 2018). This explains the apparent congruity between the willingness to protect and the willingness to harvest tortoises expressed by children. Similarly, well-intentioned people consider it appropriate to extract tortoises from a dangerous wild environment (e.g., full of predators, without easy access to food and water; Pérez et al., 2012), or to rescue them from burnt habitats. But long-term investigations have revealed that even severely burnt landscapes remain appropriate for tortoises (Lecq et al., 2014). Appearances can be deceptive: a surviving tortoise walking in a forest devastated by fire can still find food and refuge and thus should not be "rescued", especially because removing individuals from impacted populations further compromises viability (Nikolic et al., 2018). As such, the lack of accurate ecological information may trigger inappropriate decisions. This assumption is supported by the analyses showing that the level of knowledge positively influences appropriate conservation attitudes. Children that provided the most accurate responses regarding species identification, suitable habitats (i.e., natural setting), or protection status were less prone to consider tortoises as pets and to harvest them, despite a high level of likeability. Nonetheless, a high proportion of well-informed children declared that they may remove individuals from the wild (Figure 3). Thus, a relatively high knowledge level was insufficient to ensure an effective conservation attitude. This might be also a consequence of the controversial status of tortoises in the particularly confusing French legislation: various *Testudo* species are legally sold, including the Hermann tortoise which is nonetheless strictly protected in the wild (CITES Convention on International trade in endangered species of Wild Flora and Fauna). Besides the influence of incomplete knowledge, the general knowledge of the children surveyed was relatively weak; although it slightly increased with age. For instance, habitat destruction, the most important threat for tortoises, was rarely cited (Lagarde et al., 2012; Livoreil, 2009). Our results suggest that, although children express strong concerns to protect tortoises, most children have no clear or accurate ideas about conservation issues.

### Future directions

We did not investigate if the high popularity of tortoises actually explains this conservation paradox; but we cannot imagine a similar situation with an unpopular species. Cultural and educational factors probably play a strong role in the inappropriate attitude of the children. Indeed, children clearly express a preference for a limited number of categories of animals (e.g., predatory wild mammals, domestic mammals, pets) irrespective of extinction risks of ecological threats (Ballouard et al., 2015; Bjerke, Ødegårdstuen, & Kaltenborn, 1998; Borgi & Cirulli, 2015). Future studies should examine the usefulness of tailoring outreach activities somewhat to dovetail with conservation priorities: improving the likeability of unpopular species *versus* decreasing the attractiveness of vulnerable and popular species. One practical recommendation of this study is hence that increasing the likeability of tortoises is not a priority considering the potential undesirable effects (Tisdell, 2010). This recommendation does not apply to other reptiles; snakes notably suffer from a strong deficit of popularity and would benefit from a better image (Ballouard, Provost, Barré, & Bonnet, 2012).

Many factors involved in the attitude of schoolchildren were not examined and/or discussed in this study (e.g., girls express more sympathy for animals than boys [Kellert & Westervelt, 1984], a result confirmed here by their high likeability score), but our results nonetheless show that accurate ecological knowledge and precise information are essential for conservation education (Loyau & Schmeller, 2017). Yet, research into environmental education has already identified the complexity of the interplay between the affective domain, social and ethical factors; these factors ultimately influence pro-environmental attitudes (Eagles & Demare, 1999; Schultz, 2014). Basing environmental education on a pure rationale of ecological knowledge is thus unrealistic. Instead, emotion is a powerful tool with which to elicit pro-environmental attitudes; virtually all media campaigns rely heavily on it (Douglas & Veríssimo, 2013;

Kals, Schumacher, & Montada, 1999; Pooley & O'Connor, 2000). Unfortunately, emotion-driven conservation policies can be counterproductive (Douglas & Veríssimo, 2013; Shine, 2011). Moreover, our study shows that the level of popularity should be used cautiously.

## Conclusion

Educational activities should take into account the subtle equilibrium between information obtained indirectly (e.g., via media) and the knowledge acquired during outdoor activity, which is, unfortunately, in strong decline (Hofferth, 2009; Pergams & Zaradic, 2008; Soga & Gaston, 2016). Attending popular movies or documentaries *versus* participating in field trips are very different methods. Nonetheless, they can both stimulate positive attitudes for threatened species by triggering emotion. But well-organized field trips are tailored to effectively enhance both likeability and the willingness to protect species in their natural habitats. Outdoor activities are thus less likely to generate undesirable side "effects" (children demanding wild animals as pets) compared to actions based on virtual approaches that are automatically disconnected from natural conditions (Ballouard et al., 2012). This claim reinforces previous conclusions supporting findings that show how outdoor experience is better suited in promoting balanced attitudes toward nature than environmental education exclusively carried out in the classroom (Aarts, Wendel-Vos, van Oers, Van de Goor, & Schuit, 2010; Arendt & Matthes, 2016; Bogner, 1998; Braun, Buyer, & Randler, 2010; Chawla, 1998; Collado, Staats, & Corraliza, 2013; Crompton & Sellar, 1981; Kellert, 2002). Achieving this objective does not necessarily entail the organization of expensive field trips to remote natural reserves; neighborhood areas that retain fascinating elements of the flora and fauna (e.g., arthropods) offer excellent substratum for the development of ecologically driven emotional experiences that may favor effective pro-environmental attitudes (Spork, 1992; Uhls et al., 2014; Wells & Lekies, 2006). Positive environmental outdoor experiences organized for children and based on natural history should be considered as a fundamental, accessible and regular activity.

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