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How contact with nature affects children's biophilia, biophobia and conservation attitude in China

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ABSTRACT

The widening gap between humans and nature, driven by urbanization, seems to be an indisputable fact in the modern world. Such a gap may breed apathy towards environmental concerns and wildlife, which would not bode well for the future of biodiversity conservation. However, the consequences of the decline in physical contact with nature are poorly understood, especially in China, which is urbanizing faster than any other country. In this study, we aimed to understand how contact with nature affects children's propensity for biophilia and biophobia, and their conservation attitudes. Fifteen schools with different degrees of urbanization were selected and 1119 pupils aged 9–10 filled out questionnaires. The students reported how frequently they engaged in fifteen outdoor activities, and these scores were summed together to produce a measurement of their contact with nature. The participants were shown twelve specimens of common wild animals in order to examine their biophilia and biophobia, and their willingness to conserve animals. We found children from urban schools had less contact with nature than those from rural schools, although this result was only marginally significant because of one outlying rural school. The children's contact with nature was significantly positively related to their biophilia and negatively related to their biophobia. Children's biophilia, in turn, significantly affected their willingness to conserve animals, and, to a lesser extent, their general attitudes about conservation. As a whole, the study suggests that contact with nature may enhance children's willingness to support animal conservation indirectly by nurturing biophilic attitudes to wildlife.

1. Introduction

Childhood experience about nature is known to support major developmental processes of adolescence (Kellert, 2002) and increase children's physical and mental health, and their skills in multiple domains (Miller, 2007). Direct and concrete experiences with nature (hereafter referred to as "contact with nature") are considered an efficient way to promote positive attitudes towards biodiversity conservation (Turpie, 2003). A large amount of evidence has also demonstrated the benefits of contact with nature, and an emotional bond with wildlife, for the environmental attitudes and behaviors of adolescents (Collado and Corraliza, 2013; Collado et al., 2013; Duerden and Witt, 2010; Müller et al., 2009), although there are clearly many other factors also influencing such attitudes and behaviors (Kollmuss and Agyeman, 2002). Environmental educationists therefore have stressed activities that increase children's contact with nature (Bogner, 1998; Farmer et al., 2007; Yardimci and Leblebicioglu, 2012). Indeed, when adult environmentalists are asked about the origin of their commitment to protect the environment, they frequently mention positive experiences with nature during childhood (Chawla, 1999; Chawla and Cushing, 2007; Wells and Lekies, 2006). Nevertheless, studies that focus on how contact with nature affects children's attitude towards wildlife conservation are relatively scarce (but see Ballouard et al., 2012; Zaradic et al., 2009).

Given the potential importance of the relationship between people's experiences in nature and biodiversity conservation (Miller, 2005), it is worrisome that there has been a pervasive decline in outdoor recreation among adults and outdoor activities among children in recent decades (Hofferth, 2009; Pergams and Zaradic, 2008). One driving factor is sprawling urbanization, with more people living in cities now than ever before (Cohen, 2006). Urban areas are highly modified, human-dominated environments where green spaces have shrunken over time (Turner et al., 2004). The wedge between children and nature is driven deeper by another increasingly scarce resource, free time. Children's lives

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have shifted indoors from outdoors, reflecting the rise of virtual entertainment and more sedentary lifestyles for children (Clements, 2004). Children have few opportunities to experience nature by themselves, increasing their estrangement from nature and the occurrence of unwanted side-effects, termed 'nature-deficit disorders' (Louv, 2008).

Can the decline of contact with nature lead to a lack of favorable feelings about nature? People are believed to have an instinctive love for nature and living things, as suggested by the biophilia hypothesis (Kellert, 1993; Wilson, 1984). Early discussion about biophilia mainly concentrated on humans' psychological well-being when exposed to natural features and environments (e.g., rivers, mountains; Ulrich, 1993) and suggested that it is innate. New research, focused more on emotional responses to animals, suggests that biophilia is learned and experiential (Simaika and Samways, 2010). This idea remains controversial, although it is supported by studies in which children's favorable attitudes or interests in plants and animals are enhanced by observing and interacting with them (Ballouard et al., 2012; Lindemann-Matthies, 2005; Tomazic, 2011). Stokes (2006) has suggested that the expression of biophilia must be triggered through contact with nature, perhaps at a young age, otherwise, biophobia, defined as "the fear of living things and aversion, and alienation from nature", may develop (Simaika and Samways, 2010; White and Stoecklin, 1998). For the purposes of this study, we define biophilia and biophobia as children's affective attitudes (like and fear) toward common wild animals, acknowledging that this does not cover the full biophilic concept, and we investigate whether such biophilia and biophobia is affected by contact with nature.

The role of affective attitudes toward nature has been demonstrated to be very important to the development of people's conservation behaviors by numerous models and studies (Ajzen, 1991; Collado et al., 2013; Kaiser et al., 1999; Mulder et al., 2009). Indeed, such attitudes sometimes can be much greater than the role of cognitive considerations in influencing peoples' involvement in biodiversity conservation (Martin-Lopez et al., 2007). It has thus been proposed that the cultivated appreciation of animals be a way of encouraging biodiversity conservation (Simaika and Samways, 2010). Yet few empirical studies have been conducted to test this suggestion (but see Martin-Lopez et al., 2007; Ballouard et al., 2012). At the same time, biophobia has been shown to decrease people's support for protecting animals (Johansson et al., 2012; Knight, 2008). However, the animals presented in these studies were endangered large carnivores not personally experienced by the subjects, and the investigations were conducted through a set of pictures rather than tangible specimen of animals (Knight, 2008). In this study, we aimed to explore whether children's affective attitudes – biophilia and biophobia – towards mounted displays of common but ecologically significant animals could affect their conservation attitudes. Further, we look into whether contact with nature also directly affects conservation attitudes, or does so indirectly, mediated through biophilia and biophobia.

This study was conducted in China where urbanization and other socio-economic changes are occurring more rapidly than any other country (Wan, 2011). The proportion of the population in urban areas has risen from 39.1% in 2002 to 51.3% in 2011, which means more than 20 million people are added to the urban population every year (Zou, 2011). As young people move from the countryside to a city or town for their education (Fu and Liu, 2012; Qian and Geng, 2007; Xu, 2010), Chinese children are faced with the extinction of nature experience (Bao, 2011). Systematic studies to understand how contact with nature declines along the urbanization gradient and the possible consequence of this decline for psychology and attitudes to biological conservation in China are clearly needed.

We conducted an intensive survey of primary school children, from schools spread geographically across China and along the urbanization gradient. In order to understand how contact with nature affects children's biophobia, biophilia and conservation attitude, a series of hypotheses were developed in this study (Fig. 1): H_1: Urbanization will significantly affect children's contact with nature; children in cities will have less contact with nature than those in countryside. H_2: Contact with nature will in turn influence children's biophilia positively and biophobia negatively. H_3: Biophilia, biophobia and contact with nature will affect positively children's willingness to conserve animals and their general attitudes towards conservation. Since gender has been shown to be an important variable influencing biophilia (Bjerke et al., 1998; Kellert and Berry, 1987), we incorporate it as a factor in all our analyses.

2. Methods

2.1. Participants and study sites

The surveys were conducted from April to September 2012. A total of 1119 children from 15 elementary schools participated in the surveys. These schools were located in three rural areas, three small cities, three large cities and two metropolitan cities (Beijing, Shanghai) in China. Schools and cities investigated were chosen on the basis of their geographical spread, and their position on the gradients of urbanization as measured by local per capita Gross Domestic Product (per capita GDP) and resident population density (Table S1).

Children aged 9–10 in grade four of each school participated in the study. We targeted this age group because it is a critical period of cognitive development and the understanding of animals (Kellert, 2002). Middle grade children at this age can experience their nearby wild or semi-wild natural world independently. All human-related and informed consent protocols were approved by all the schools investigated and approval to approach schools was granted by the schools' principals.

2.2. Measures of key constructs

We designed a questionnaire that addressed the following topics: (1) children's contact with nature, (2) children's biophilia, (3) children's biophobia, (4) willingness to conserve animals and (5) their general attitudes toward animal conservation. All constructs were assessed using a Likert-like three point scale with emotive face symbols to make it easy for children to understand (Appendix S2).

Children's answers to all the items in the questionnaires were filled completely by themselves in their classrooms after the animal observation time. They were not allowed to communicate with others while filling the questionnaires. If they had questions, they were allowed to ask for clarification from their teacher or the investigator.

2.3. Children's contact with nature

To measure children's contact with nature, we followed Harvey's (1989) procedure to develop our own scale. Two classes of children in grade four (about 120 students) from one school located in Menglun, Mengla, Yunnan Province, China, a town of about 20,000 inhabitants near our institution, were asked to write freely about all the activities they had experienced with common wild animals and plants. From these lists, we chose the 15 most frequently mentioned outdoor activities, such as "catch butterflies", "plant trees", "observe insects pollinating plants", etc. (see

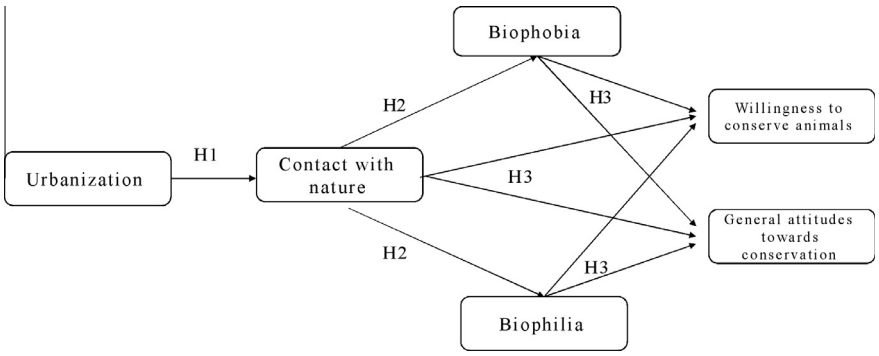

Fig. 1. Hypotheses framework illustrating relationships between children's contact with nature, their biophilia, biophobia and willingness and attitudes toward animal conservation.

Appendix S2). We then asked each student how often he or she engaged in the experiences listed in the formal survey. For each item, "never" was coded 0; "occasionally" coded 1; "often" coded 2. For each student we summed together his or her scores on each outdoor activity to calculate a total score of contact with nature.

2.4. Children's biophilia

Following the studies of Bjerke et al. (1998) and Schlegel and Ruf (2010) about children's reactions towards animals, we presented 12 kinds of animal specimens (Fig. 2) to the children to measure their biophilia. The species chosen were common (distributed across the whole country) and a good representation of different animal groups (mammals, birds, reptiles, amphibians, spiders, and insects). Each participant was asked to individually enter a room where the 12 dead specimens were mounted in transparent plastic cases, similar to displays in natural history museums, and displayed on the desks for an observation time of 3–5 min. After the observation time, children were asked whether they liked or disliked each animal in the questionnaire (e.g. "How do you feel about lizards?"). For each animal item, "like" was coded 1; "no feeling" coded 0; "dislike" coded -1.

2.5. Children's biophobia

We decided to only use animals in this study, because we believed that biophobia in particular would not be elicited by mounted version of plants (although children might be scared of plants at larger scales, such as forests, we could not recreate that in a classroom). To test for biophobia, we used the same animal displays as those used for biophilia. After the observation time, children were asked whether they would be afraid of encountering these animals. For each animal item, "very afraid" was coded 2; "a little afraid" coded 1; and "not afraid" coded 0.

2.6. Willingness to conserve animals

After the presentation of the animal models, we asked the students whether they would like to conserve these animals (e.g., "would you like to protect earthworms?"). For each response, "yes" was coded as 2, "no idea" as 1, and "no" as 0.

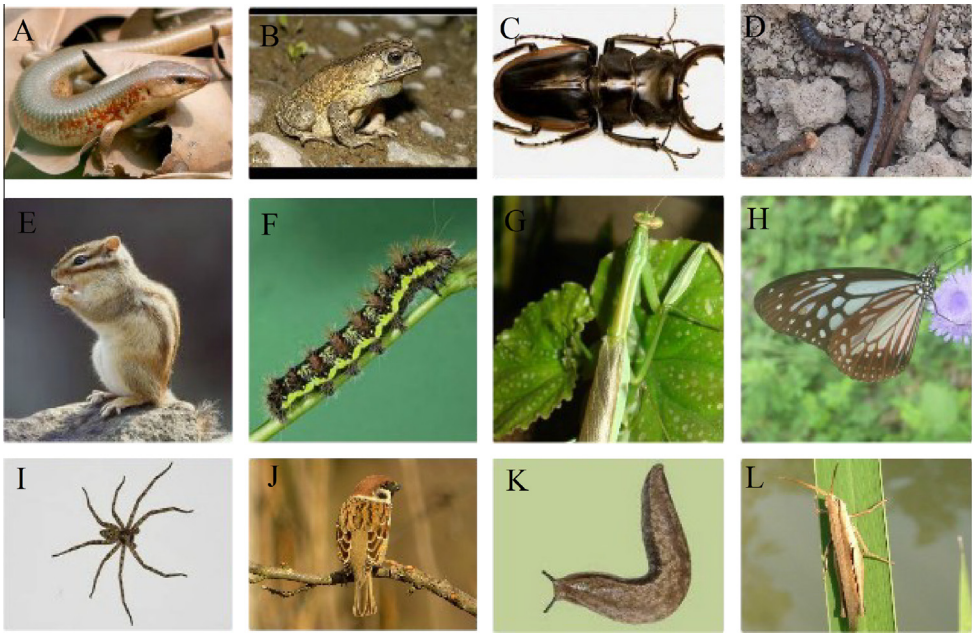

Fig. 2. The 12 species of common wild animals that were used to test children's biophobia, biophilia and their willingness toward animal conservation. (A) Chinese skink (*Eumeces chinensis*), (B) Chinese toad (*Bufo bufogargarizans*), (C) Beetle (*Coleoptera sp.*), (D) Earthworm (*Amynthas sp.*), (E) Squirrel (*Sciurus carolinensis*), (F) Caterpillar (*Lepidoptera sp.*), (G) Chinese mantis (*Paratenodera sinensis*), (H) Cabbage butterfly (*Pierisrapae Linne*), (I) Spider (*Araneae sp.*), (J) Sparrow (*Passer montanus*), (K) Slug (*Agriolimax agrestis*), (L) Grasshopper (*Acrida sp.*). In the survey, children were allowed to observe dead, mounted specimens of these animals for 3–5 min.

2.7. General attitudes toward animal conservation

A scale was developed in the questionnaire to gauge children's general attitudes towards animal conservation, following the studies of Dimopoulos and Pantis (2003) and Torkar et al. (2010). We asked students nine questions, including questions about the perception of wildlife ($n = 4$, examples included "Only useful animals and plants need protection"; "It is wrong for people to wear clothes made from animal fur"), affective concern ($n = 3$, examples included "We should care for and conserve all plants and animals"; "I am interested in the T.V. show "Animal World""), and behavioral intentions or verbal commitment ($n = 2$; "I would like to donate my money to protect animals"; "I will prevent other people from harming animals"). For each item, "agree" was coded 1; "no idea" as 0; "disagree" as −1.

2.8. Analyses

We excluded the scores of butterflies, sparrows, and squirrels in the scales because more than 95% of students rated them "like", "not afraid", and showed willingness to conserve them, and thus there was too little variation in the answers to make these animals useful in the analysis. For each student, the combination of their scores for the nine species yielded a proxy for biophilia, biophobia, and willingness to conserve animals, respectively. The reliability of these scales was considered good for biophilia, biophobia and willingness to conserve (Cronbach's $\alpha = 0.83$, 0.84, 0.83, respectively). The reliability of the scales for contact with nature and general attitude towards conservations were considered adequate ($\alpha = 0.71$ and 0.61).

To understand the effect of urbanization on children's contact with nature (hypothesis 1), we constructed a general linear mixed model, with the type of city (rural, small city, large city, metropolis) as the fixed factor, and the school identity as the random factor. General linear mixed models were fit using the *lme4* package (Bates et al. 2012) of R software, version 3.0.2 and Tukey honest significant differences (HSD) were calculated for multiple comparisons using the package *multcomp* (Hothorn et al., 2012).

To test hypotheses 2 and 3, we developed a series of general linear mixed models to test whether: (a) biophilia or biophobia were dependent on contact with nature and gender (male was assigned "1", female "0"); (b) willingness to conserve animals was dependent on contact with nature, biophilia, biophobia, and gender; and (c) general attitudes toward animal conservation were dependent on contact with nature, biophilia, biophobia and gender. General linear mixed models were run as above including school identity as a random factor, and square root transformations were used when applicable to improve homoschedasticity and normality. To select the final models, we sequentially removed non-significant interactions and fixed factors. ANOVA statistics were calculated using Type III Sum of Squares, so that the effects of different fixed factors were independent of each other. We estimated R^2 for the final models following Nakagawa and Schielzeth (2013).

We also used structural equation modeling (SEM) to test for mediation effects. In this analysis, biophilia and biophobia were used as both independent and dependent variables, mediating the relationship between children's contact with nature and their conservation attitudes. We developed a path diagram for the SEM conducted with AMOS 20.0. Maximum likelihood estimation was used to calculate model parameters. A 5000 resamples bootstrap method and bias corrected 95% confidence intervals (CI) were used to estimate whether the mediation effect was significant (Preacher and Hayes, 2008). The goodness-of-fit of our model was assessed by chi-square χ^2 test, root mean square error of approximation (RMSEA) and comparative fit index (CFI; Hooper et al., 2008).

In the structural equation model, the initial model illustrated by hypotheses 2 and 3 framework fitted the empirical data poorly ($\chi^2 = 543.93$, $df = 2$, $p = 0.00$). Thus, we re-specified the model by omitting the non-significant path coefficients.

3. Results

3.1. Children's contact with nature in different schools in China

When schools were classified according to their position on the urbanization gradient, rural schools had high values for contact with nature (Fig. 3A). However, there was a large amount of variation within the schools of a particular urbanization category, particularly among rural schools, where one outlying school had the lowest contact with nature of all schools (Fig. 3B). A general linear mixed model showed that urbanization category was marginally significant in predicting contact with nature ($X^2_3 = 6.63$, $P = 0.085$), although no multiple comparisons were significant (all Tukey HSD > 0.117). If, however, the one outlying rural school was removed from the dataset, contact with nature was highly significantly influenced by urbanization ($X^2_3 = 26.95$, $P < 0.001$), with students in rural schools having higher contact with nature than any other category (all Tukey HSD < 0.001).

3.2. General linear mixed models examining the relationships between the key constructs

Biophilia and biophobia were significantly affected by children's contact with nature.

Contact with nature significantly increased biophilia and significantly decreased biophobia (Table 1). Gender was also a factor that had a significant effect on children's propensity for biophilia and biophobia (see Table 1). Female students had higher propensity for biophobia than male students ($\text{Mean}_{\text{female}} = 7.67$, $\text{Mean}_{\text{male}} = 3.90$), while male students were more inclined to biophilia than females ($\text{Mean}_{\text{male}} = 0.76$, $\text{Mean}_{\text{female}} = -1.36$).

Children's willingness to conserve animals was significantly increased by biophilia, though not affected by biophobia or contact with nature (see Table 1). Gender was a relatively minor, though significant, factor. Children's general attitude towards conservation, however, was more strongly affected by gender ($\text{Mean}_{\text{male}} = 6.40$, $\text{Mean}_{\text{female}} = 7.28$). Biophilia marginally significantly ($p = 0.083$) increased general attitudes towards conservation (see Table 1), but other factors were not significant, and the full model with both gender and biophilia only explained 4% of the variation in general attitudes towards conservation.

3.3. The mediating effects of biophilia and biophobia as shown by SEM

Our final model for predicting children's willingness to conserve included only the pathway between contact with nature and biophilia, and the pathway between biophilia and willingness to conserve (Fig. 4A). This mediated effect by biophilia was strongly significant ($\beta = 0.12$, Bias-corrected confidence interval: 0.09–0.16, $p < 0.001$).

The final model for predicting general attitude towards conservation was similar: contact with nature affected biophilia and that affected general conservation attitude (Fig. 4B). The mediation effect of biophilia was still significant, though less powerful than the one in the model for willingness to conserve ($\beta = 0.02$, Bias-corrected confidence interval: 0.01–0.03, $p < 0.001$).

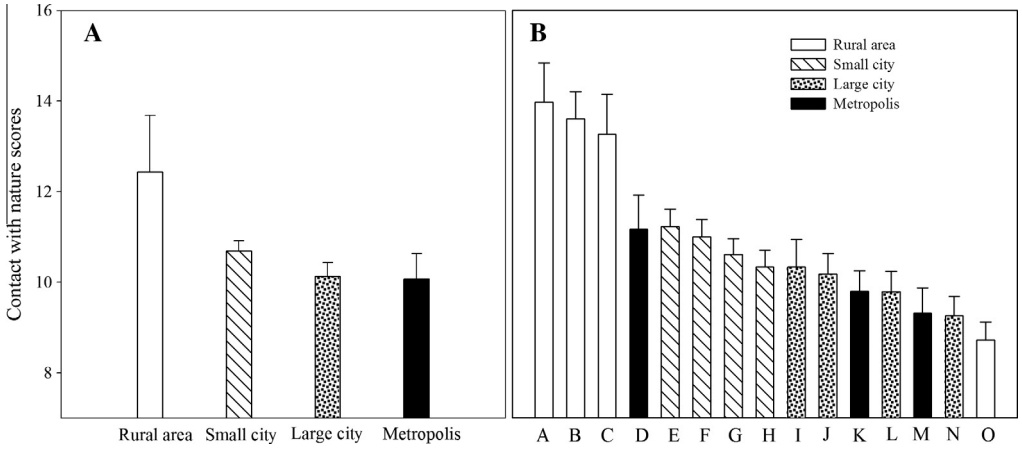

Fig. 3. Variation in children's contact with nature, by urbanization category, and by schools. Children in rural schools tended to have high scores of contact with nature, except that one rural school was a large outlier, having very low contact with nature scores. (A) The data with the unit of replication being school; for each urbanization category (rural, small city, large city, metropolises) the contact with nature represents the mean score of the schools in that category (n = 15 schools). (B) The data broken down by school, with the mean score of all students at each school (n = 1119 students). Each of the 15 outdoor activities (see Appendix S2) was scored a '0' for 'never', '1' for 'occasionally' and '2' for 'often', and then the scores for all questions were summed together. School names and their abbreviations as in Table S1.

Table 1
Results from generalized linear mixed models about the relationships among the key constructs. School was included as a random factor in the models, significance tests used Type III sum of squares, and the estimation of R^2 follows Nakagawa and Schielzeth (2013). Models predicting willingness to conserve and general attitude towards conservation originally included the factors of biophobia and contact with nature, but these were removed as they were non-significant. All interactions were non-significant.

Dependent variable	Independent variable	Slope (b)	Std. error	χ^2_1	p	Estimate R^2
Biophobia	Intercept	3.21	0.15	440.90	<0.001	0.21
	Contact with nature[a]	−0.19	0.04	20.80	<0.001	
	Gender[+]	−0.90	0.06	240.68	<0.001	
Biophilia	Intercept	−3.45	0.41	69.59	<0.001	0.10
	Contact with nature	0.21	0.03	52.29	<0.001	
	Gender[b]	1.98	0.24	68.45	<0.001	
Willingness to conserve animals	Intercept	12.07	0.35	1183.21	<0.001	0.20
	Biophilia[a]	1.66	0.14	133.05	<0.001	
	Gender[b]	−0.98	0.28	12.00		
					<0.001	
General attitude towards conservation	Intercept	7.31	0.39	349.01	<0.001	0.04
	Biophilia[a]	0.21	0.12	3.01	0.083	
	Gender[b]	−1.15	0.23	23.97	<0.001	

[a] Variable was square root transformed.
[b] A positive number means that male students had higher values of the response variable than did female students.

4. Discussion

This study, for the first time in China, explored children's contact with nature along a gradient representing the rapid urbanization and socio-economic development of the country, and the consequence of a decline in contact with nature from both psychological and conservation perspectives. Generally, children in rural schools had more contact with nature than children in urban schools, supporting our first hypothesis, but the presence of one outlying school, discussed more below, indicates that the process of urbanization is complex. Contact with nature showed a significant positive impact on children's biophilia and negative impact on biophobia, confirming our second hypothesis. While contact with nature did not have a direct effect on willingness to conserve animals, the SEM model showed it did have a significant indirect effect on willingness to conserve, mediated through biophilia. There was a similar significant indirect effect of contact with nature on general attitudes towards conservation, but the effect size was small, so our third hypothesis was partially supported. Our findings affirm the idea that a decline in human interactions with the natural world, known as the "extinction of experience", is a threat to the conservation of biodiversity (Miller, 2005).

4.1. Urbanization influences contact with nature

Rural children had in general more contact with nature than those students from cities, but schools showed high variation among each other, particularly in rural areas. Due to diminished green space and limited time due to the prevalence of electronic products, urban children have fewer chances to encounter wild nature (Pergams and Zaradic, 2006; Turner et al., 2004). This is probably why many (62%) of Chinese parents in cities wish their children can experience green spaces away from urban areas (Bao, 2011). Interestingly, it was not an urban school but one in rural areas near Kunming, Yunnan Province, that had the lowest scores for nature experience. This school is surrounded by a new high-tech development zone and modern universities, with limited green space for children to play. In addition, most children's parents are migrant workers who often leave their children alone at home, or with their grandparents, and children are not given chances to access wild nature under guidance from their parents. The expansion of high-tech development zones to rural areas and large numbers of rural migrant workers may be China-specific phenomena, and they emphasize the fact that urbanization is never a simple process (Fu and Liu, 2012). Particular attention should be

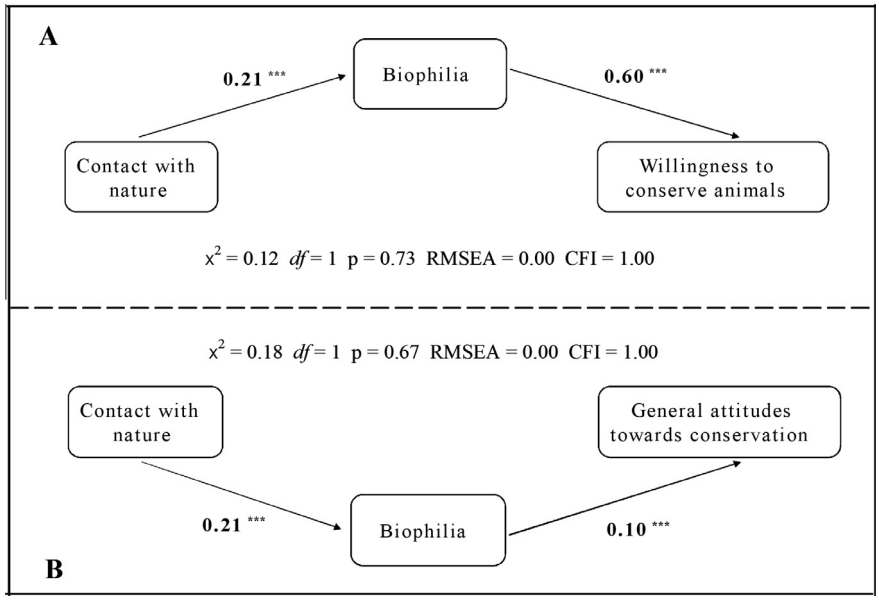

Fig. 4. Final models for the structural equation models. The original models contained all constructs in hypotheses 2 and 3 (see Fig. 1), but the fit was poor. Non-significant path coefficients were then deleted and the model re-specified. Asterisks (***) indicate that these path coefficients were significant at $p < 0.001$.

paid to the environmental education of this group of children in order to increase their contact with nature.

4.2. Contact with nature improves biophilia/biophobia to animals

There was a significant effect of contact with nature on children's biophilia/biophobia, although the regression model indicating that contact with nature and gender only explained 22% and 10% of the total variance of biophobia and biophilia, respectively. Undoubtedly, children's biophilic and biophobia attitudes are influenced by many factors. Yet other research has shown that children's perceptions of animals are affected by past and present interactions with particular species. For example, there was a strong positive correlation between the levels of participation in an outdoor activity day and immediate interest in local biodiversity in Paris (Shwartz et al., 2012). For children and adolescents, positive associations have been found between participation in animal-related activities, such as fishing, feeding birds, and reading about animals and liking these animals (Bjerke et al., 2001). Children's interest in wildlife can also be stimulated by hands-on experience with animals (Fančovičová and Prokop, 2011). Outdoor activities related to wildlife, such as catching butterflies and observing wildlife in the wild, offer longer and more complex play than indoor activities (White and Stoecklin, 1998) and have the potential to trigger the powerful affective channels of children (Ballouard et al., 2012).

Direct and concrete experiences with nature can also change initial negative attitudes toward animals (biophobia). This idea is supported by a study indicating that children who encountered toads in the wild had more favorable attitudes toward toads than children without such experiences (Tomazic, 2011). Similarly, the proportion of French children that declared they were afraid of snakes before and after a field trip, decreased markedly from 33.2% to 10.6% (Ballouard et al., 2012). It has also been demonstrated that children's unfound fears toward the natural environment develop when they have had very little actual contact with living things and obtained most of their attitudes through the electronic media (Cohen and Horm-Wingerd, 1993). Hence our finding that contact with nature reduces biophobia is also consistent with previous research.

Gender was a powerful predictor of biophilia and biophobia in this study, with male students more inclined to show positive emotional response to wild animals. This result has also been shown by previous studies (Bjerke et al., 1998; Kellert and Berry, 1987). Boys may face pressure from peers and parents to be unafraid of wildlife, whereas girls may be encouraged to be afraid (e.g., discouraged from outdoor activities and being 'tomboys'), and social desirability may be a strong force (e.g., Crowne and Marlow, 1960; Holtgraves, 2004).

4.3. How contact with nature, biophilia and biophobia influence children's willingness to conserve animals and their general attitudes towards conservation

Biophilia to animals played an important role in children's desire to conserve these animals. Studies have demonstrated that humans are inclined to show a positive conservation attitude towards those animals they have experience or affinity with (Ballouard et al., 2012; Stokes, 2007). Researchers have proposed that human attitudes towards animals are explained by two dimensions: affect, representing people's affective and emotional responses to non-human species, and utility, representing people's perceptions of the species' instrumental value (Serpell, 2004). The role of affective factors may play a greater role in decision making than any knowledge people may have about the scientific and ecological need for conservation (Martin-Lopez et al., 2007; but, for other studies that find the importance of cognitive factors, see: Collado et al. 2013; Pooley and O'Connor, 2000). Researchers have also shown that a fear of animals can reduce people's interest in their conservation (Johansson et al., 2012), but here we did not see a direct influence of biophobia on conservation attitudes.

Although we did not see a direct influence of contact with nature on conservation attitudes, the indirect effect, mediated by biophilia, was positive and significant. This result echoes the findings of two recent studies. In a cross-cultural study, it was shown that emotional affinity toward nature contributes significantly to pro-environmental commitment, while spending time in nature does not have a direct impact on this commitment (Müller et al., 2009). The effect of children engaging in summer camps on their

willingness to carry out environmental practices also was mediated by the increase in emotional affinity with nature (Collado et al., 2013). An emotional bond with nature seems a critical driver of conservation attitudes (Cheng and Monroe, 2012; Collado and Corraliza, 2013), and contact with nature, especially early in childhood, can contribute to such a bond.

Although biophilia significantly promoted conservation attitudes, we note that the overall proportion of the variance explained by our models was relatively low, especially for predicting the more abstract concepts represented in the questions about general attitudes towards conservation. For example, in Müller et al.'s (2009) model, emotional affinity explained 22% of variance in willingness to participate in environmental causes, similar to the percent of variation explained in our study (20% of variance in willingness to conserve animals). However, the Collado and Corraliza (2013) and Cheng and Monroe (2012) studies, discussed above, explained 37% and 35% of the variance in environmental behaviors, respectively, in their models, compared to the 4% of variance for general attitudes towards conservation explained here. The divergent results may be related to differences in the constructs used: "restorative experience" (Collado and Corraliza, 2013) and "connection to nature" (Cheng and Monroe, 2012) are both psychological constructs, and hence perhaps more closely correlated with pro-environmental attitudes than physical contact with nature is in our study.

Some limitations of our methods may also have contributed to the low power of our models to explain conservation attitudes. For example, the 3-point nature of the questionnaire may have limited measurement of subtle differences in attitudes. It is noteworthy that the reliability of the scale for general attitudes towards conservation was only marginally acceptable ($\alpha = 0.61$). We must acknowledge that our data represents reported biophilia, attitude, willingness etc. rather than the actual state; as mentioned above, social desirability may have influenced the children's responses and this could add noise to the data and explain some of the low explained variances. Finally, our measurement of biophilia on dead, mounted specimens may have depressed emotional attachments, although natural history museums attract many students using similar displays. More generally, however, the unexplained variance probably represents a multitude of factors shaping children's attitudes towards conservation (Chawla, 1998; Cheng and Monroe, 2012; Kollmuss and Agyeman, 2002). For instance, in our study, female students had higher scores for willingness to conserve and general attitudes towards conservation despite having lower biophilia, which suggests that there are complex social factors that influence such attitudes.

5. Conclusions and implications

In summary, contact with nature generally improved children's propensity for biophilia, which in turn significantly enhanced children's willingness to support the conservation of animals in China. Contact with nature can be enhanced by programs run by botanical gardens and zoological parks, by increasing green areas and their accessibility and safety to urban children, and by summer camp programs that introduce such children to the outdoors (White, 2004). Unfortunately, such practices are now neglected by environmental education, as direct experiences of local natural areas are replaced with virtual ones (Pergams and Zaradic, 2006). We further emphasize the importance of children's affective responses to nonhuman species, and the potential role educational programs can have in influencing these responses. Educators should try to develop children's love for plants and animals and dispel fear and toxic perceptions of wildlife when teaching about biological conservation issues (Knight, 2008; Lindemann-Matthies, 2002). Finally, we note that urbanization such as that occurring currently in China has the potential for causing a vicious cycle, with reduced amounts of green space near humans diminishing people's value for the nature that is left.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.biocon.2014.06.011.

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