

Perceived body condition is associated with fear of a large carnivore predator in humans

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Natural selection affects emotional and behavioural patterns, such as anti-predator adaptations, that enhance human survival. Fear is a basic emotion that activates behavioural responses upon encountering a predator, being consistently higher in females than in males. In this study, we investigated associations between fear of a large carnivore predator and perceived physical condition in a sample of Slovakian participants ($n = 943$). When testing evolutionary hypotheses explaining gender differences in fear of predators, we found partial support for the “physical condition” hypothesis, because females either reported lower perceived body condition than males and their perceived body condition showed significant correlation with fear of brown bear, *Ursus arctos*. The negative association between fear and perceived body condition was stronger in males suggesting that fear evolved as a response to higher predation pressures on males in our evolutionary past, indirectly supporting the “predation pressure” hypothesis. Males and participants with higher fear of bears wanted to exterminate bears by shooting more than others, suggesting that future management strategies should be oriented on elimination of fear of predators, as primary predictor of extremely negative attitudes toward bears.

Introduction

Early humans were mainly hunter-gatherers (Laughlin 1968), however, scavenging on mammalian carcasses is now considered to be a realistic alternative to hunting (Turner 1988, Cavallo & Blumenschine 1989). Human ancestors 1 800 000–600 000 years ago shared habitats with diverse species of large predatory carnivores (Treves & Palmqvist 2007). Hominids directly competed with (Shipman 1986) or

were hunted by some paleopredators (Stanford & Bunn 2001) and their attempts to defend or steal carcasses probably increased the risk of being attacked by predators (Treves & Palmqvist 2007). Consistent with these arguments, many of the remnants of *Australopithecus anamensis* show carnivore damage (Leakey *et al.* 1998); e.g. one hominid skull had tooth punctures caused by a leopard's gripping bite (Brain 1981).

Primates, as well as recent hunter-gatherers living in traditional societies, avoided encoun-

tering predators by avoiding dangerous areas, behaving inconspicuously, producing alarm and mobbing calls, using refuges such as trees, or counterattacking a predator (Corbett 1954, Busse 1980, Boesch 1991, Tsukahara 1993, Hill & Hurtado 1995, Noronha 1999). Behavioural adaptations protecting humans against danger are typically associated with emotions, namely fear (Seligman 1971, Öhman *et al.* 1975, Barrett 2005). According to Öhman *et al.* (2001) and Öhman and Mineka (2003), human and nonhuman primates possess an evolved fear mechanism towards fear-relevant stimuli such as harmful animals. This fear mechanism predisposes children and adults to attend dangerous animals and prepares them to rapidly learn how to associate fear with such stimuli (biological preparedness hypothesis).

Most works focusing on biological preparedness typically involve spiders and snakes, leaving fear of large carnivore predators unstudied (Arrindell 2000, Røskaft *et al.* 2003, Kaltenborn *et al.* 2006) despite the fact that thousands of modern humans fall prey to large carnivores (Corbett 1954, Turnbull-Kemp, 1967, McDougal 1987, Treves & Naughton-Treves 1999, Peterhans & Gnoske 2001, Kruuk 2002, McNay 2002). Most works consistently reveal that as compared with males, females fear predators more (Kellert 1985a, 1985b, Bjerke *et al.* 1998, Davey *et al.* 1998, Ericsson & Heberlein 2003, Røskaft *et al.* 2003, Kleiven *et al.* 2004, Kaltenborn *et al.* 2006, Gerdes *et al.* 2009, Røskaft *et al.* 2007, Prokop *et al.* 2009, Rakison 2009, Prokop & Tunnicliffe 2010) and, as compared with males, prefer different escape strategies in the presence of a predator (Coss & Moore 2002). There are at least three not mutually exclusive hypotheses trying to explain the relatively higher fear of females to carnivores and other dangerous animals. The “reproductive investment” hypothesis states that females generally invest more in reproduction than males (Trivers 1972), thus avoiding harmful animals or disease agents increases the likelihood of further investment in offspring (Fessler & Navarrete 2003, Curtis *et al.* 2004, Prokop *et al.* 2010). The “physical condition” hypothesis states that females have lower physical condition than males and are, therefore, more likely to be killed by large carnivore pred-

tors (Treves & Naughton-Treves 1999, Røskaft *et al.* 2003). According to the “predation pressure” hypothesis, men were hunters (Kaplan 1996, Røskaft *et al.* 2004) and therefore had to deal directly with many dangerous animals (Hawkes *et al.* 1991). Women, on the other hand, probably stayed in the close vicinity of their camps because their parental duty was to raise and care for children. Thus, women more easily evolved fear toward animals of threat. Surprisingly, very few works have provided empirical support for these hypotheses. The first hypothesis implicitly assumes that women who have more children (and therefore invest more into reproduction) should have greater fear of harmful animals, but we are not aware of any study that test this hypothesis. The second hypothesis assumes that physical condition is an important predictor of survival; data testing this assumption are however not available. The last hypothesis is difficult (if not impossible) to test; some evidences however reveal that males are under stronger predation pressure than females (Treves & Naughton-Treves 1999, Packer *et al.* 2007), supporting the fact that men are faced with dangerous animals more frequently than females (Hawkes *et al.* 1991).

The present study is devoted to testing the “reproductive investment” and “physical condition” hypotheses. We conducted a survey of fear of brown bear (*Ursus arctos*), the largest carnivore predator in Slovakia, central Europe. This carnivore was chosen because it causes most fatal attacks on humans relative to other available predators like wolf (*Canis lupus*) or lynx (*Lynx lynx*) (Røskaft *et al.* 2003). Moreover, in the past, direct persecution in combination with habitat destruction led to near extinction of brown bears in central Europe (Breitenmoser 1998, Kaczensky 1999), thus research examining the effect of fear on human attitudes toward large carnivore population regulation can help in planning management strategies. In support of the “reproductive investment” hypothesis, we predict that (1) as compared with males, females have greater fear of bears, and (2) number of offspring a female has correlates with the fear level of bears. Because offspring number correlates with male reproductive investment, a relation between the fear level and offspring number in

males is also predicted. However, given a sexual conflict mediated by uncertainty of paternity and a higher investment in offspring during pregnancy (Goetz & Shackelford 2009a), this relationship should be stronger in females than in males. In support of the “physical condition” hypothesis, we predict that (1) females have lower perceived physical condition than males, and (2) there is a negative correlation between fear of bears and physical condition in females. Considering that males were historically under stronger predation pressures than females (Hawkes *et al.* 1991, Treves & Naughton-Treves 1999), the possibility that male physical condition and fear will correlate cannot be ruled out. Finally, we asked what factors predict people’s attitudes toward bear extermination. In line with the evolutionary predictions described above, we predict that participants with greater fear of bears are more willing to shoot bears as compared with participants with a lower fear level.

Methods

Participants

Data surveys were conducted between September and June in 2008 and in 2009. Participants were 943 children and undergraduate students attending several Slovakian primary schools ($n = 294$), high schools ($n = 301$) and the Trnava University ($n = 348$). The mean age (\pm SE) of participants was 21.06 ± 0.36 years (range = 10–64 years). Most of the participants (77%) were ≤ 25 years old. The mean age of university students was higher than a typical undergraduate sample because all students at the campus where the study was conducted differ from traditional students by e.g., being employed full-time and/or having several children. This yielded a more diverse subsample of participants compared with studies involving only full-time university students. The numbers of males and females were 415 and 528, respectively. Participants were asked to provide basic sociodemographic variables such as gender, age, body weight and height, number of children. We computed each participant’s body mass index (BMI): $\text{mass}/(\text{height})^2$ as an indicator of physical condi-

tion. Although body weight and height were not measured directly, there is evidence that people report those with surprising accuracy (Stundkart & Albaum 1981, Palta *et al.* 1982).

Research instruments

All participants completed a set of three questionnaires focused on fear of bears, perceived physical condition, and attitudes toward sport activities, respectively. All statements were rated by participants on a five Likert-type scale (1 = strongly disagree to 5 = strongly agree). To assess fear of bears, 6 statements from the Spider Phobia Questionnaire (Kindt *et al.* 1996) were selected. Those were primarily developed to examine fear of spiders, thus we changed the term “spider” to “bear”: e.g. “If somebody tells me that bears are somewhere around me, I get nervous”, “Even the thought of touching a bear scares me”, “I fear bears”, or “Bears scare me more than other animals”. Five additional statements were added by us (e.g., “The only good bear is a dead bear”, “I would like to meet a bear in forest” [reversely scored], “When I am going to the woods, I am cautious because bears might be there”). To assess perceived physical condition, six statements modified from the Physical Strength Subscale (Hagger *et al.* 2004, Klomsten *et al.* 2004) were used. They included e.g., “I am physically stronger than other people of the same age and sex”, “I am able to be physically active for a longer time without break”, “I am a physically strong person”, “I am unsure whether I have enough energy and power” (reversely scored). Attitudes toward sport activities were assessed using 17 statements of which some were created by us and some adopted from the Sport Competence Subscale (Hagger *et al.* 2004, Klomsten *et al.* 2004). They included e.g., “I like sport”, “I am good at most sports”, “I like difficult sport activities”, or “I am actively participating in a sport team”. All questionnaires showed acceptable reliabilities (Cronbach’s $\alpha = 0.83, 0.75$ and 0.83 , respectively). For each individual, we calculated a mean score for each questionnaire. High mean scores of the three questionnaires indicate high fear of bears, high perceived physical condition and positive attitudes toward sport activities, respectively.

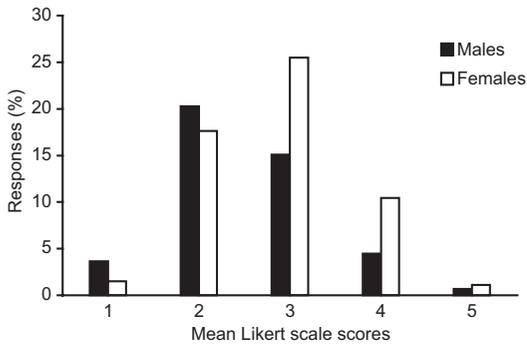


Fig. 1. Mean scores of fear of bears. High scores indicate high fear.

Participants were also asked to indicate whether bears live in their home area. This allowed us to compare the self-reported fear between groups with and without bears in their vicinity. Overall, 60 participants (6%) reported that they live in areas with bears. Further, we asked about the respondent's participation in outdoor activities: mushroom or berry picking, walking in nature, mountain hiking (0 = never, 1 = once a month, 2 = twice a month, 3 = 3–4 times per month, 4 = more than one time per week, for all three activities), and small game hunting (yes/no). The latter question was intended to detect whether parents participated in answering questionnaires given to school-age respondents, hence to control for potential effect of parents on participant's fear of bears. Finally, one question was focused on the participants' attitude towards bear extermination by shooting ("Do you think that bears in Slovakia should be exterminated by shooting, because of their high population density?"). The answer allowed for examining whether fear (or other variables) mediates negative attitudes toward bears.

Data analysis

Fear of large carnivores may be affected by participation in outdoor activities (e.g. forest-fruit picking, tourism, walking in nature, hunting: see Ericsson & Heberlein 2003, Røskaft *et al.* 2003, 2004) and/or age (positive correlation between fear and age: see Kellert 1985a, Ericsson &

Heberlein 2003, Kleiven *et al.* 2004, Røskaft *et al.* 2003, 2007; negative correlation between fear and age: see Davey 1994, Arrindell 2000, Kaltenborn *et al.* 2006). Therefore, these variables were controlled for (fear as a dependent variable) and a regression residual was taken as the dependent variable in a stepwise multiple regression model. Independent variables were gender, living in areas with or without bears and number of children. This analysis enters the independent variables in a stepwise manner in order to identify the effects of each variable independently as well as the cumulative effect of the independent variables on the dependent variable. If adding the variable contributes to the model then it is retained, but all other variables in the model are then re-tested to see if they are still contributing to the success of the model. If they no longer contribute significantly they are removed (Landau & Everitt 2004).

Self-perceived body condition correlated with age, BMI and sport attitudes ($r = -0.23$, -0.12 , and 0.70 , all $p < 0.001$) and sport attitudes correlated with the same variables (age and BMI: $r = -0.26$ and -0.23 , both $p < 0.001$), thus all these variables were controlled for and their residuals were defined as independent variables. All statistical tests were two-tailed and calculated with Statistica ver. 6 (StatSoft 2001).

Results

Factors influencing fear of bears

A substantial number of the participants feared bears (Fig. 1). A forward, stepwise, multiple regression with gender, living in areas with or without bears, perceived condition and attitudes toward sport activities showed that all independent variables entered the model ($r^2 = 0.07$, $F_{4,938} = 17.39$, $p < 0.0001$) (Table 1). As compared with males, females showed greater fear of bears, and individuals with poorer perceived body condition feared bears more than individuals with better perceived condition. These two variables were the strongest predictors of fear of bears which was also supported by a backward multiple regression which removed almost all

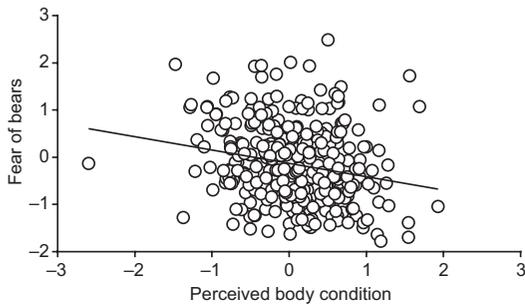


Fig. 2. Relationship between perceived body condition and fear of bears in males. Variables are controlled for confounding factors.

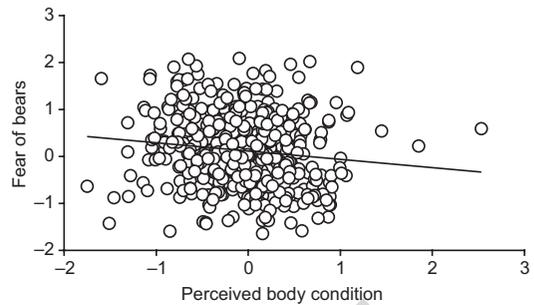


Fig. 3. Relationship between perceived body condition and fear of bears in females. Variables are controlled for confounding factors.

independent variables except for gender and perceived condition. People living in areas with bears tended to fear bears less than people living outside bear areas. Attitudes toward sport activities did not significantly predict fear of bears.

Because most of the participants were childless, we performed the same analysis for 172 participants having at least one child (mean = 1.94, SE = 0.06, range = 1–6). The results were almost identical to the above but the model was stronger ($r^2 = 0.14$, $F_{3,168} = 8.78$, $p < 0.0001$). Attitudes toward sport activities and the number of children were removed from the multiple regression model.

A separate analysis of relationships between fear of bears and perceived condition (controlled for factors explained above) showed that this relationship is stronger in males ($r = -0.21$, $p < 0.001$, $n = 415$, see Fig. 2) as compared with that in females ($r = -0.12$, $p = 0.005$, $n = 528$, see Fig. 3). Hence, although males reported having better perceived body condition than females (ANCOVA controlled for age: $F_{1,940} = 43.61$, $p < 0.001$, $\eta^2 = 0.04$), an association between fear and body condition was stronger in males than in females.

Factors influencing extermination of bears

A forward, stepwise, multiple, logistic regression with participants' attitude toward extermination of bears by shooting them (yes/no) as a dependent, binomial variable revealed that fear of bears and gender were the strongest predictors of negative attitudes. Overall, 18% of participants (172/943) accepted shooting bears. Participants with a higher fear score (controlled for confounding factors), males and participants with higher perceived body condition were more willing to shoot bears (forward stepwise logistic regression: Wald's $\chi^2 = 42.28$, 21.78 and 3.97, $p < 0.001$, 0.001 and 0.046, respectively). Living in areas with/without bears, attitudes toward sport activities and number of children were excluded from the model. Excluding childless participants or the number of children from the analysis did not affect these results.

Discussion

This study contributes to a deeper understanding of gender differences that traditionally occur

Table 1. Linear multiple regression model (forward stepwise method) on fear of bears as dependent variable.

	β	SE of β	<i>B</i>	SE of <i>B</i>	t_{937}	<i>p</i>
Intercept			22.53	5.20	4.33	< 0.001
Perceived condition	-0.22	0.05	-0.31	0.06	-4.79	< 0.001
Gender	-0.15	0.03	-0.22	0.05	-4.33	< 0.001
Occurrence of bears in the area	-0.07	0.03	-0.22	0.10	-2.28	0.02
Sport attitudes	-0.08	0.05	-0.14	0.08	-1.79	0.07

when fear of predators is examined. As far as we know, this is the first study which examined an association between fear and physical condition in humans. Our results support adaptive explanations of fear of animals revealing significant associations between perceived physical condition and fear of bears. Although works seeking correlations are traditionally limited by a lack of strong statements about causal relationships (e.g., Goetz & Shackelford 2009b), we argue that our results are explicit, because perceived physical condition influences fear, but not *vice versa*. Moreover, several important factors influencing attitudes toward predators were controlled for. One problem is that majority of the participants found bears not extremely fearful. Future research combining questionnaires with pictures or videos of predators are therefore recommended (*see* Gerdes *et al.* 2009, Prokop *et al.* 2010).

As regards the “reproductive investment” hypothesis — predicting that (1) as compared with males, females have greater fear of bears, and (2) number of offspring in females correlates with fear of bears more strongly in females than in males — only the first prediction of the hypothesis was supported, because females showed greater fear of bears than males which agrees with other research focused on large carnivores (e.g., Kellert 1985a, Bjerke *et al.* 1998, Ericsson & Heberlein 2003, Røskaft *et al.* 2003, Kleiven *et al.* 2004, Kaltenborn *et al.* 2006, Prokop & Tunnicliffe 2010). However, the second prediction that involves parental investment being crucial for the “reproductive investment” hypothesis was not supported, because the number of offspring did not correlate with fear of bears. This analysis was however restricted to 18% of all participants. These results indirectly corroborate results of Kaltenborn *et al.* (2006) who found in Tanzania that participants’ worries about their own safety and safety of their families when encountering predators are similar. However, it can be argued that women who have dependent children (too young to fend for themselves) would be more risk averse and fearful than those who do not. Unfortunately, we did not ask parents about the age of their children, thus we cannot definitely reject the “reproductive investment” hypothesis. This study casts doubt on the role of paternal investment that is

traditionally used as an explanation of emotional differences between males and females (e.g. Fessler & Navarrete 2003, Curtis *et al.* 2004, Prokop *et al.* 2010), and suggests that further critical evaluation of this hypothesis is necessary.

The “physical condition” hypothesis predicted that (1) females have lower perceived physical condition than males, and (2) there is a negative correlation between fear of bears and physical condition. This hypothesis was only partly supported, but all these results should be interpreted with caution, because we did not estimate physical condition of participants directly. However, the mean score of perceived body condition of participants showed a negative correlation with age and BMI, and a positive correlation with attitudes toward sport activities, suggesting that these measurements are valid. Although females had poorer perceived physical condition than males, which is consistent with empirical data suggesting that females less likely survive attacks by large predators than males (Treves & Naughton-Treves 1999, Røskaft *et al.* 2003), the correlation between perceived physical condition and fear in females was weak. That is, females in better physical condition fear bears similarly to females in poor physical condition. In contrast, perceived physical condition of males showed a moderate correlation with fear of bears suggesting that as compared with females, males were under stronger predatory pressures in our evolutionary past (Hawkes *et al.* 1991). Males in better physical condition would search in risky areas in terms of predation threat, and would have consequently better foraging success than their physically less robust counterparts. Females, who — as the discoveries of the earliest anthropoids from the Oligocene (Fleagle *et al.* 1980) and Late Miocene show — are known to be conspicuously smaller in body size, incur higher energetic cost of bipedal locomotion relative to larger-bodied males (Kramer & Eck 2000). They, hence, invested most of their time and energy in raising and caring for children in the vicinity of their camps (Hawkes *et al.* 1991, Kaplan 1996). In other words, lighter females would escape when encountering a predator, e.g. by climbing trees (Coss & Moore 2002), but they were not selected for active attacks. In summary, our results partially support the “physical condition”

hypothesis (Treves & Naughton-Treves 1999, Røskaft *et al.* 2003) because perceived physical condition partly predict fear of predators in females. Further, we found an indirect support for the “predation pressure” hypothesis (Hawkes *et al.* 1991), because the dependence of fear on body condition suggests that males were selected for physical races with predators.

We found a strong correlation between perceived physical condition and attitudes toward sport activities (this study), and the latter variable correlates with self-esteem (Altıntaş & Aşçi 2008). It may be that more active individuals with higher self-esteem have generally lower level of fear (Byrne 2000). Of course, sport activities, physical competition with counterparts and consequent approval by other group members (awards, teacher approval, or so) also contribute to personal awareness of own physical condition.

The final area of our research involved predictors of participants’ attitudes toward bear extermination. Like Bjerke *et al.* (1998), who investigated attitudes toward extermination of wolves, we found that substantial number of participants agreed with reducing a bear population by shooting animals. These attitudes were not negatively influenced by living in areas with or without bears (Røskaft *et al.* 2003, Kaczensky *et al.* 2004), but rather by fear and gender. Males wanted to exterminate bears more than females which would be explained by male involvement in hunting activities (Kaplan 1996, Røskaft *et al.* 2004). Importantly, participants who feared bears showed more negative attitudes toward bears. From an evolutionary perspective, these attitudes could be explained as a strategy reducing likelihood of being attacked or killed by a predator, because participants who felt more vulnerable to predation wanted to exterminate bears more than others. We propose that future management regimes should be focused especially on reducing fear of large carnivores which would consequently, positively influence attitudes toward large predators. Both physical contact (Morgan & Gramann 1989) and experiences with predators (Røskaft *et al.* 2003) are significantly associated with lower fear of predators. Allowing people to visit carnivore habitats and explaining their role in natural ecosystems together with

strategies improving human–predator coexistence would be helpful tools for improving public acceptance of large predators.

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