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RESEARCH ARTICLE

Modeling cognitive antecedents of tolerance for black bears: The roles of direct experience, knowledge, and risk perceptions

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ABSTRACT

Understanding tolerance for wildlife requires accounting for the multiple cognitive antecedents of this concept and its contextual factors. We examined whether direct experience was associated with four antecedent dimensions of tolerance for black bears (antipathy, connection, lethal control [damage], lethal control [danger to self, pets, and economics]), both directly and indirectly via risk perception, self-assessed knowledge, and factual knowledge. We collected data using intercept surveys at trailheads in western Oregon, United States (n = 210). Risk perception was most strongly related to antipathy (cost-related beliefs) and connection (benefit-related beliefs) toward black bears. Self-assessed knowledge was most strongly associated with an individual's assessment that bears are a nuisance (lethal control [damage] and a safety concern [danger to self, pets, and economics]). Direct experience was related to all four antecedents, whereas factual knowledge was not related to any dimension. Identifying drivers of tolerance can inform actionable recommendations that promote tolerance for wildlife.

KEYWORDS

Tolerance; human-black bear interactions; perceived risks; self-assessed knowledge; factual knowledge; confirmatory factor analysis

Introduction

Conservation initiatives attempt to promote human tolerance for wildlife, both to protect wildlife and to support livelihoods (Frank, 2016; Messmer, 2000). Based in a conservation paradigm that views people as a cause of environmental changes and a potential solution to conservation challenges (Balasinorwala et al., 2004), these initiatives encourage understanding and addressing both individual level (e.g., emotions, cognitions, behaviors) and societal level (e.g., policies, economies) responses to conflicts with wildlife to successfully "increase tolerance." Common symptoms of human conflicts with wildlife (defined as negative impacts of humans or wildlife on each other; Conover, 2002) include agricultural damage caused by wildlife (Karanth et al., 2012), poaching of wildlife (Conover, 2002), and deeper-rooted social issues among humans (Madden & McQuinn, 2014). The idea behind cultivating tolerance is to prevent these events and build ecosystems in which humans and wildlife mutually co-adapt to sharing landscapes. Without exploring determinants of tolerance in specific contexts, practitioners and researchers may not fully understand the experiential and social psychological factors related to human responses toward wildlife.

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Tolerance is an ambiguous and complex concept open to competing interpretations, ranging from "putting up with" to "willingness to accept" (Brenner & Metcalf, 2019; Bruskotter & Fulton, 2012; Glikman et al., 2021; Lischka et al., 2019; Slagle & Bruskotter, 2019; Treves et al., 2013). In this article, we conceptualize tolerance following Brenner and Metcalf (2019) as "accepting wildlife and/or wildlife behaviors that one dislikes," which represents the diverse conceptualization in the literature. Tolerance includes a response to a stimulus (an object, event, or action). This response could be emotional, cognitive, or behavioral, and may be informed by a person's beliefs, attitudes, norms, or other characteristics. Tolerance can be positive in nature (passive inaction, willingness to accept, refraining from harming others or wildlife) becoming, in some cases, active coexistence (benefit-related beliefs or attitudes plus taking positive action; Frank & Glikman, 2019). Yet, some researchers contend that tolerance only comes into play when there is a prior dislike or a difficult and divisive situation (Knopff et al., 2016). As a result, the concept of tolerance is commonly applied in cases of intolerance (cost-related beliefs or negative attitudes plus intention to take negative action) toward wildlife or events that are viewed as a nuisance or risk (e.g., Naughton-Treves et al., 2003).

Tolerance and intolerance are often understood as opposite ends of a unidimensional factor structure (e.g., Lewis et al., 2012; Treves et al., 2013). For example, wildlife acceptance capacity (WAC) is measured as the desired change in the size of a wildlife population (Decker & Purdy, 1988) and is commonly used as a metric for tolerance, although its potential lack of grounding in social psychological theory has been acknowledged (Zajac et al., 2012; Zinn et al., 2000). WAC assumes that people who want a wildlife population to increase are "tolerant," whereas those who want it to decrease are "intolerant." However, this unidimensional approach may be limited insofar as it does not capture the many cognitive antecedents of tolerance. People are tolerant or intolerant for different reasons and they may tolerate a stimulus (or decide not to) that can be viewed as a nuisance or risk in different ways (Bruskotter et al., 2015). Thus, an approach that considers the multiple antecedents of tolerance can offer a broader understanding of how different cognitive factors and contexts are related to the dynamic nature of tolerance (Bruskotter et al., 2015).

The multiple expressions of tolerance and the interdependency of its cognitive components have led others to conceptualize tolerance as multidimensional (Brenner & Metcalf, 2019; Bruskotter et al., 2015). We agree with this perspective and apply a conceptualization that includes belief statements measuring four antecedent dimensions of tolerance developed using a psychometric scale development process (Delie et al., 2022). These antecedent dimensions include an individual's cost-related beliefs (antipathy dimension) and benefit-related beliefs (connection dimension) about a species, as well as their beliefs on lethal actions to manage the species (lethal control [damage], lethal control [danger to self, pets, and economics] dimensions). Taken together, these dimensions capture a range of a person's cognitive responses to wildlife encounters and incidents, sometimes called "response extremity" (Zinn et al., 1998), which could be related to the person's direct experiences and other cognitive factors.

All encounters between humans and wildlife occur at particular times and in specific environments with the proximity, length of time, and frequency of such encounters differing (Messmer, 2000). A person's affective and cognitive responses to these encounters are not only associated with preexisting values, attitudes, expectations, knowledge, and skills (Zinn et al., 2008), but also with how they perceive the impact of the encounter. These perceived impacts can be positive, neutral, and negative, including, for example, an emotional connection, an ecological benefit, a financial cost, or a safety threat. What an individual "learns" from a given stimulus and the specific context in which the encounter occurs affects how they respond in the future and ultimately their tolerance for interacting with the species (Wilbur et al., 2018).

Although personal experiences with wildlife have been widely studied along with other determinants of tolerance (e.g., Inskip et al., 2016; Lischka et al., 2019; Struebig et al., 2018; Western et al., 2019; Zajac et al., 2012), much of this research examined tolerance unidimensionally, representing either beliefs, attitudes, norms, or behaviors. Our article seeks to expand the social-psychological understanding of variables associated with tolerance by testing whether direct experience from seeing black bears is related to any of the four theoretically informed antecedent dimensions of tolerance (see, Figure 1) directly or indirectly via other identified predictors of tolerance in the literature, including knowledge and risk perception.

Hypothesis Development

Experiences can play a role in belief and attitude formation (Duerden & Witt, 2010; Fazio & Zanna, 1981). Given that our conceptual model of tolerance antecedents includes beliefs, we hypothesized that direct experience from simply seeing a species (black bears) would be positively associated with tolerance antecedents for the species. However, various other types of direct experiences and contexts have been studied in relation to tolerance. For example, Lischka et al. (2019) found that safety and nuisance related experiences with wildlife did not affect residents' tolerance and that perceived benefit was a stronger factor related to tolerance. Some other studies have shown that individuals are less tolerant of encounters with wildlife and favor lethal control of species, especially in areas where there may be fewer direct encounters or in cases where individuals experienced negative events such as losing a domestic animal due to wildlife (e.g., Eriksson & Herberlein, 2003; Knopff et al., 2016; Naughton-Treves et al., 2003). Others have found that childhood direct experience with nature can be positively related to tolerance in situations where wildlife did not cause any problems (e.g., Hosaka et al., 2017). Indirect (e.g., zoos, nature centers) and vicarious experiences (e.g., books, media, observing, or listening to others) are also of importance in influencing cognitive and affective development, as people often learn from others (Carlson et al., 2020; Fazio & Zanna, 1981; Karlsson & Sjöström, 2007). Regardless of whether experiences are positive or negative, beliefs and attitudes formed through direct experiences can be more resistant to change, easily recalled, and likely to be held in long-term memory compared to cognitions shaped by indirect or vicarious experiences (Fazio & Zanna, 1981), suggesting that direct experiences, even from simply seeing a species, may be more strongly associated with tolerance.

Tolerance can also be related to risk and benefit perceptions associated with a stimulus. Risk perceptions are intuitive judgments (as opposed to expert assessments) of the threat from a hazard or the likelihood of being exposed to a hazard (Needham et al., 2017; Witte, 1992). Although some recent tolerance studies have shown perceived benefits to be an equal or a stronger predictor than risks (e.g., Kansky et al., 2016; Lischka et al., 2019; Slagle et al., 2013), decades of risk research suggest that beliefs about the likelihood of a negative consequence are strongly related to the nature of a person's responses to wildlife (Witte, 1992). In fact, the psychological model in Zajac et al. (2012) shows that risk and benefit perceptions are strongly and inversely correlated, and explain 62% of the variance in tolerance for black bears. Similarly, Struebig et al. (2018) found that tolerance toward Sumatran tigers was partly associated with the perceived risk of encountering this species, and Schroeder et al. (2018) found that risk-based beliefs were more strongly associated with preferences for wildlife management than were benefit-based beliefs. If one perceives an animal (e.g., black bear) as a safety threat, then one might have more negative (or cost-related) beliefs about the animal. This threat perception may also lead one to accept efforts to decrease the population of that species, which is one way that tolerance has been measured (e.g., Inskip et al., 2016). We hypothesized, therefore, that perceived risk would be associated with antecedents of tolerance for the species.

Studies have suggested that increasing tolerance entails promoting awareness of risks associated with encountering wildlife, knowledge on how one can mitigate those risks, and understanding ecological facts about wildlife (Flemming et al., 2018; Hosaka et al., 2017; Western et al., 2019). Arbieu et al. (2020), for example, found that greater factual knowledge (defined as whether a person does or does not know factual information on a species) about wolf populations was related to tolerance via the likelihood of residents reporting positive experiences. In other words, the effect of factual knowledge depended on whether someone also had a positive experience with wolves. However, the metacognition literature suggests that self-assessed knowledge can be as important as factual knowledge for mental processing tasks, such as problem-solving (Bandura, 1986). Although research has shown that self-assessed and factual knowledge are related, they are also identified as two different constructs (Ladwig et al., 2012). Self-assessed knowledge is how much someone thinks they know or has learned about a particular issue, whereas factual knowledge captures concrete content (e.g., terminology) and there is a factually correct answer (Ladwig et al., 2012; Perry et al., 2014; Radecki & Jaccard, 1995). Assessing the impact of knowledge on tolerance or its antecedents may yield different results depending on which types of knowledge are measured (Ladwig et al., 2012). There is limited research examining relationships between different types of knowledge and antecedents of tolerance for wildlife. Our paper examined this issue, hypothesizing that the two knowledge constructs are positively related and individuals with more knowledge (both factual and self-assessed) have a lower risk perception of wildlife and more positive beliefs toward wildlife, and thus are less likely to accept actions that decrease the population of a species.

Studies have also suggested that direct experience helps to develop an individual's knowledge, which in turn can alter their beliefs (Eriksson et al., 2015). Duerden and Witt (2010), for example, found that children's direct experience in nature provided opportunities for the attainment and application of already acquired knowledge about the environment. That is, while knowledge of ecological facts can be gained through indirect experiences, direct experiences provide opportunities to apply this knowledge or strengthen it, such as reading about black bears climbing trees and then seeing a bear climb a tree. Research has also shown that how much knowledge people perceived they have gained from an encounter with nature may be indicative of the experience (Powell & Ham, 2008). Alternatively, seeing wildlife in a beneficial way – in a non-hostile or threatening environment – can stimulate interest and motivate an individual to seek new information, thus increasing their knowledge (Curtin, 2010). Therefore, we hypothesized that direct experience of seeing a species will be positively related to both factual and self-assessed knowledge.

Antecedents of Tolerance Model

Delie et al. (2022) identified four antecedent dimensions of tolerance for black bears in a study with recreationists in Oregon. These antecedent dimensions represent a series of belief statements and may or may not extend to specific behavioral intentions or behaviors, as other research on tolerance for wildlife has done (e.g., Bruskotter et al., 2015). For this study, we theorized that these antecedent dimensions of tolerance are on the same level of the cognitive hierarchy with correlated paths among these dimensions. Predictors of these dimensions were direct experience and other cognitions (i.e., knowledge, risk), as theorized in various social-psychological frameworks (e.g., cognitive hierarchy, value-attitude-behavior; Fulton et al., 1996; Homer & Kahle, 1988; Stern, 2018). Our hypotheses are illustrated in Figure 1 with unidirectional arrows representing the expected direction of relationships and bi-directional arrows (correlative paths) representing the expected correlations between concepts.

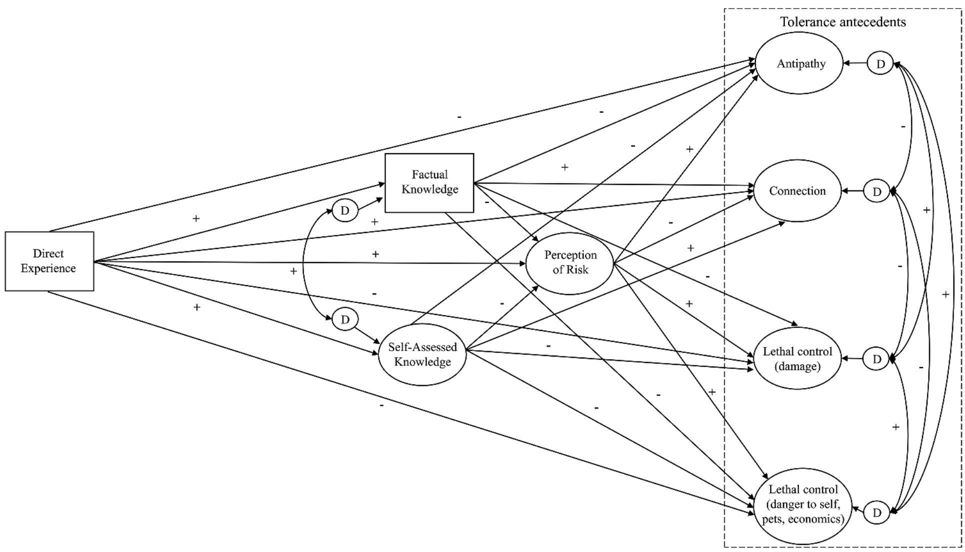

Figure 1. Hypothesized model of relationships among concepts (positive [+] or negative [-] relationship). A box represents an observed/manifest factor, and an oval represents a latent factor. D = disturbance/error for endogenous factors.

Methods

Study Context

In the United States, Oregon is native habitat to an estimated 25,000 to 35,000 black bears that occupy almost 46% (113,665 km^2) of the state's total land area (Oregon Department of Fish and Wildlife, 2012). Black bear populations are stable or increasing in some regions, with densities being highest in deciduous-coniferous forests along the coast range, Cascade Mountains, and in the Blue Mountains located in the northeast of the state (Csuti et al., 2001; Oregon Department of Fish and Wildlife, 2012).

Oregon is also home to about 4.2 million people, the majority of whom live in cities such as Portland, Eugene, and Salem (U.S. Census Bureau, 2020). Oregon is experiencing a substantial human population increase, with a 9.5% growth since the 2010 Census (U.S. Census Bureau, 2020). Growing human populations contribute to greater availability of anthropogenic food sources (e.g., garbage, fruit trees, beehives) for black bears (Lackey et al., 2018). This available food, coupled with competition for space and resources, is a primary cause of human encounters with black bears that can manifest into conflict. The Oregon Department of Fish and Wildlife (ODFW) groups human conflict with bears by human safety threats (real and perceived) and types of damage (e.g., nuisance, agricultural). Managers in wildlife agencies resolve conflicts by non-lethal or lethal removal of a bear, with the largest number of lethal removals associated with damage to human property, including damage to merchantable timber plots. In ODFW's most recent year of collecting data on resident complaints about damage caused by black bears (Oregon Department of Fish and Wildlife, 2012), the agency received 920 complaints and reported 388 out of 501 non-hunting black bear deaths to be the result of nuisance or damage (Oregon Department of Fish and Wildlife, 2012). Most (90%) of those non-hunting mortalities occurred in western Oregon (Oregon Department of Fish and Wildlife, 2012). Given Oregon's black bear management plan outlines strategies to avert human conflict with bears, we reasoned that this local setting provided context for understanding relationships among direct experience, risk perception, self-assessed knowledge, factual knowledge, and antecedents of tolerance for black bears.

Data Collection

We designed this study to sample across documented spaces of black bear encounters in Oregon and we used an in-person intercept survey to collect data (Bernard, 2006). We applied a stratified sampling approach (Vaske, 2019) to select intercept sites based on: (a) human–black bear encounter density, (b) location of wildlife management unit, and (c) popularity of recreational trailhead. We calculated encounter density from ODFW's documented bear mortality point data statewide from 2008 to 2017 (n = 14,966), using data from the top three mortality categories: hunter–harvest, bears taken to protect timber resources, and bears taken to protect safety of human life, property, and pets. Encounter density was calculated across 59 wildlife management units after removing nine units in which no documented bear encounter had occurred. Encounter density areas were categorized from "low encounters" to "high encounters" using the following calculations: "low" = M (*mean*) – SD (*standard deviation*) and lower, "medium-low" = M – SD to M, "medium" = M, "medium-high" = M + SD to M, and "high" = M + SD and higher. We narrowed sampling locations to six wildlife management units west of the Cascade Mountains based on two experts' (i.e., wildlife biologists) opinions as to where human encounters with bears occur in Oregon, selecting areas with "medium" to "high" encounter densities to account for potentially diverse experiences with black bears (see, Figure 2).

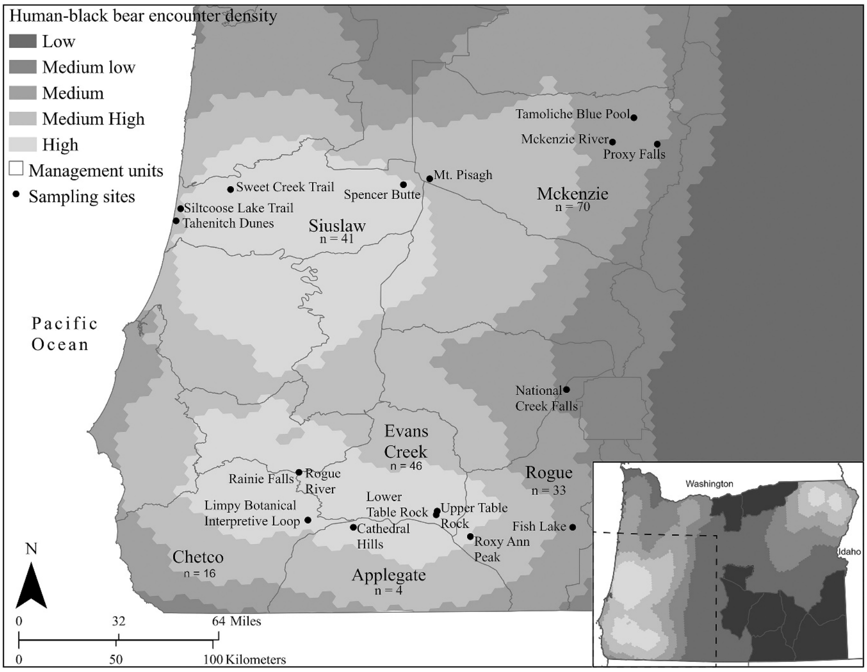

Figure 2. Study area and survey intercept sites in Oregon, United States. Color gradient displaying black bear encounter densities that was calculated using Oregon Department of Fish and Wildlife 2008–2017 statewide black bear mortality data (n = 14,966). n = the total number of individuals who completed our questionnaire for each wildlife management unit.

To sample in environments where interactions with black bears were likely to occur and to maximize potential respondents, we identified popular recreational trailheads based on variance (medium to high) bear encounter density. Popular trailheads were trails with a top 30% ranking on Alltrails.com and four or more written reviews in the previous three months before data collection. Alltrails.com is a web-based collection of international trail guides with more than 10 million users who can evaluate and comment on each trail system. We sampled a total of 17 trailheads at these popular recreational sites.

We collected survey responses from August to October 2018, from 8:00 until 19:00, seven days per week. If no trail users were observed over three consecutive hours on any given day, we moved to another site or tried the next day. Every solo person and group of people encountered was asked to participate, with one group member self-selecting to fill out the questionnaire. Trail users were counted as non-respondents if they declined when approached. Common reasons for non-response included time constraints, avoidance of the researcher (e.g., “maybe when I get back”), the presence of young children, and lack of interest. Individuals over 18 years of age who agreed to participate were provided with an iPad and typically spent 12–15 minutes completing the questionnaire.

Operationalization of Model Factors

Our four antecedent dimensions of tolerance were measured with belief statements validated in a prior scale development study (Delie et al., 2022 in press; Table 1). These antecedent dimensions included: (a) antipathy, represented by four belief statements referring to dislike for or annoyance at black bears; (b) connection, represented by nine belief statements revealing an individual's attachment or relationship to bears and their population levels; (c) lethal control (damage), through four belief statements on lethal actions to manage bears that cause damage to property or crops; and (d) lethal control (danger to self, pets, and economics), represented by two belief statements on lethal actions to manage bears that harass or kill domestic pets. These measures and their response scales are listed in Table 1.

The questionnaire also measured direct experience, risk perception, and both self-assessed and factual knowledge. Similar to Eriksson et al. (2015), we focused on direct experience in the form of personal encounters of seeing wildlife by asking, "Have you seen a black bear in the wild?" If respondents answered that they had, they were then asked to recall when they last encountered a bear. Responses to the two questions were combined and recoded for a single observed (i.e., manifest) factor of direct experience (never [0], over 5 years ago [1], in the last 5 years [2], in the last year [3], in the last month [4], last week [5]). In a slight modification of methods by Heneghan and Morse (2018), we asked respondents to report their risk perceptions using the five items listed in Table 1. We followed methods like those used by Needham and Morzillo (2011) for measuring self-assessed knowledge (Table 1) and factual knowledge (Table 2). For self-assessed knowledge, respondents evaluated their perceived understanding ("do not understand" to "fully understand") of four issues related to black bear ecology and management in Oregon. For factual knowledge, respondents answered "true," "false," or "unsure" to five statements. Responses were scored as correct (1) or incorrect (0) and indexed (0–5) based on the number of correct answers for a single observed (i.e., manifest) factor, with more correct answers reflecting higher factual knowledge. "Unsure" responses were recoded as incorrect. Content for items measuring both self-assessed and factual knowledge came from ODFW's black bear management plan (Oregon Department of Fish and Wildlife (ODFW), 2012). We asked knowledge questions early in the questionnaire to avoid potential order effects or starting point bias (Vaske, 2019).

We asked information on age, sex (male, female), and self-identified community of residence (rural farm, rural non-farm, small town, small city, mid-size city, large city). Respondents also provided their zip code of primary residence, which we recoded into Oregon's ten regions (north coast, central coast, south coast, Willamette Valley, Portland metro, southern, central, Mt. Hood, northeastern, southeastern; DOR, n.d.). Zip codes not in these regions were coded as "primary residence outside of Oregon."

Data Analysis

Frequency statistics summarized responses to our questionnaire items. We tested for differences between demographic characteristics and the four antecedent dimensions of tolerance using one-way analyses of variance (ANOVAs) and eta (η) effect size statistics, and for differences between direct experience and factual knowledge using chi-square tests and phi (ϕ) effect sizes. We also calculated Cronbach's alpha coefficients to measure reliability of the multiple-item indices measuring the latent factors of antipathy, connection, lethal control (damage), lethal control (danger to self, pets, and economics), self-assessed knowledge, and risk perception. An alpha coefficient ≥ .65 and item total correlations ≥ .40 generally suggest that items are reliably measuring the same concept and justify combining them for further analyses (Vaske, 2019). We ran these analyses in SPSS 26.0 and RStudio 3.6.3. Missing values in all items did not exceed 9% and a *p*-value greater than .05 suggested that all values were missing completely at random (MCAR; χ^2 = 263.94, *degrees of freedom* [*df*] = 324, *p* = .994; Little, 1988). We used multivariate imputation by chained equations to generate values for the missing data (Van Buuren, 2018). No responses were deleted, for a 5:1 respondents-to-item ratio (generally sufficient for structural equation modeling [SEM] analyses; Byrne, 1994).

We conducted SEM using EQS 6.1 software to test our theoretical framework and hypotheses in Figure 1. This statistical approach has two basic parts: a measurement model and a structural model. We first estimated the measurement model using confirmatory factor analysis (CFA) to describe the extent of interrelations and covariation (or lack thereof) among latent factors and their observed measures. The structural model then examined the hypotheses in our proposed model. We used the Satorra–Bentler (S–B) Robust estimation procedure to account for the effect of multivariate non-normality because multivariate skewness, kurtosis, and the Mardia's coefficient of 113.32 indicated some violations of the normal distribution assumption required for these analyses. To assume normality, the Mardia's coefficient should be close to zero and generally less than three or four (Maruyama, 1998). Model evaluation, therefore, was based on the S–B scaled chi-square (S–B χ^2) and the Robust corrected comparative fit index (CFI*), non-normed fit index (NNFI*), incremental fit index (IFI*), root mean square error of approximation (RMSEA*), and normed χ^2 /df (* denotes Robust estimation and correction). In general, CFI, NNFI, and IFI values ≥ .90, RMSEA values ≤ .08, and χ^2 /df ratios of 2:1 to 5:1 suggest an acceptable model fit (Byrne, 1994). To consider the significance of estimated parameters, we used S–B robust corrected standardized coefficients (ß) and reviewed all items for correlation.

Results

Descriptive Findings

In total, 347 trail users were approached and 210 completed the questionnaire, yielding a 61% response rate. Sample size ranged from four to 70 individuals across the six wildlife management units sampled in (Figure 3). Fifty-five percent of all respondents were male, 44% were female, and 1% identified as "other." Age groups were 18–24 = 11%, 25–30 = 16%, 31–45 = 26%, 46–65 = 30%, and 65 or older = 17%. Respondents self-identified their community of residence as rural areas (35%) and large cities (11%), but most (54%) selected small (10,001 to 99,999) and mid-size cities (100,000 to 1 million). A majority (69%) lived in Oregon (central = 2%, central coast = 4%, south coast = 4%, Portland metro = 9%, Willamette Valley = 22%, and southern region = 28%), 22% lived out of state, and 9% did not provide their zip code.

On average, respondents had neither a high nor a low antipathy for black bears ($M = 3.01$, $SD = 1.40$ on a 7-point scale from 1 “strongly disagree” to 7 “strongly agree”), a slightly high connection to black bears ($M = 4.64$, $SD = .97$ on same scale), and relatively little assessment for lethal control of bears that either damage property or crops ($M = 2.32$, $SD = 1.09$ on same scale) or harass or kill a pet ($M = 2.38$, $SD = 1.37$ on same scale; Table 1). There were no significant or substantial differences in the mean antecedents of tolerance by age ($F_{4, 205} = .11–1.23$, $p = .300–.978$, $\eta = .05–.15$), sex ($F_{2, 207} = 1.32–2.68$, $p = .071–.270$, $\eta = .11–.16$), or self-identified community of residence ($F_{5, 204} = .32–1.94$, $p = .090–.898$, $\eta = .09–.21$).

Seventy five percent of respondents had direct experience with black bears. Of those, the largest proportion (45%) had encountered a bear in the last one to five years and 4% had seen a black bear in the past week of when sampled. Despite a majority (57%) of all respondents perceiving bears as presenting “low” or “no risk,” 28% perceived risk to livestock, 35% perceived risk to the safety of children, 23% perceived their personal safety to be at risk, 25% believed that bears posed a risk to personal property, and 39% perceived pets to be in danger. The average risk perceptions ranged from 2.77 to 3.16 (on a 6-point scale from 1 “no risk at all” to 6 “very high risk”) across the five statements, with a mean index of 2.97 ($SD = .82$; Table 1).

Most (84%) evaluated their self-assessed knowledge of black bear ecology and management as “do not understand” to “slightly understand” (on a 4-point scale from 1 “do not understand” to 4 “fully understand”). For example, a majority (82%) “slightly understood” how bears are managed in Oregon and (84%) “slightly understood” regulations for black bear hunting. However, 36% of respondents “moderately understood” where black bears live. On average, the self-assessed knowledge statements ranged from 1.66 to 2.54 with a mean index of 2.03 ($SD = .79$; Table 1). For factual knowledge, responses to the five true/false items showed that respondents were relatively knowledgeable ($M = 3.41$, $SD = 1.32$), with the highest percentage (34%) answering four statements correctly (Table 2). There was a significant difference between those who had direct experience and those who had no direct experience in their answers to four of five factual statements ($\chi^2 = 4.22–19.49$, $p = .001–.040$; Table 2). The effect sizes ($\phi = .14–.31$) showed the strength of these differences was “minimal” to “typical” based on guidelines from Vaske (2019).

Measurement Model

According to the CFA, the data provided an acceptable measurement model fit (CFI* = .91, NNFI8 = .89, IFI* = .91, RMSEA* = .05, χ^2 [569] /*df* [386] = 1.47). All factor loadings were greater than .40 (Table 1; Maruyama, 1998), ranging from .52 to .92, and significant at $p < .05$. Reliability coefficients showed high internal consistency for each latent factor (i.e., ≥ .65; Table 1), suggesting that the items reliably measured their respective concepts. Cronbach’s alphas ranged from .81 to .87, and all item total correlations exceeded .40. Deletion of any individual items did not improve reliability.

Table 1. Measurement model results, reliability, and descriptive statistics of multiple-item indices measuring latent factors/concepts (n = 210).

Items and Factors/Concepts	Mean (*M*)	Standard Deviation (*SD*)	CFA factor loadings	Item total correlation	Alpha if deleted	Cronbach's alpha (α)
Self-assessedknowledge[a]						.86
Where black bears live in Oregon	2.54	1.01	.77	.68	.83	
How black bears are managed in Oregon	1.68	.85	.80	.74	.81	
Regulations of black bear hunting in Oregon	1.66	.90	.71	.65	.84	
Human-black bear interactions in Oregon	2.24	.99	.84	.76	.80	
Average (*M*) index	2.03	.79				
Risk perception[b]						.87
Risk posed to livestock	2.95	.96	.61	.56	.87	
Risk posed to safety of children	3.07	1.06	.92	.78	.82	
Risk posed to personal safety	2.77	1.00	.86	.78	.82	
Risk posed to personal property	2.89	.97	.52	.62	.86	
Risk posed to pests	3.16	1.06	.72	.71	.83	
Average (*M*) index	2.97	.82				
Antecedents of tolerance[c]						
Antipathy						.82
I don't want any black bears in my community	2.65	1.63	.66	.55	.82	
Black bears on my property make me uncomfortable	3.58	1.89	.70	.72	.75	
Black bears on my neighbor's property make me uncomfortable	3.12	1.79	.79	.78	.72	
Living with black bears in my area is difficult because I worry about safety	2.74	1.57	.70	.56	.82	
Average (*M*) index	3.02	1.40				
Connection						.86
There are too few black bears in Oregon	4.23	1.26	.60	.66	.83	
Black bear populations should remain high even if they are a nuisance	5.07	1.49	.53	.47	.85	
The more black bears in Oregon, the better	4.28	1.36	.68	.68	.83	
Oregon Fish and Wildlife management should work to increase the population of black bears	4.44	1.40	.52	.57	.84	
There are too few black bears in North America	4.51	1.39	.52	.58	.84	
When I see a black bear up close, it makes me happy	4.42	1.61	.59	.53	.85	
I would like to see black bears as often as I can	4.62	1.51	.67	.59	.84	
People should learn how to coexist with black bears	5.93	1.18	.58	.49	.85	
When I see a black bear in the neighborhood, it makes me happy	4.21	1.55	.74	.67	.83	

(*Continued*)

Table 1. (Continued).

Items and Factors/Concepts	Mean (*M*)	Standard Deviation (*SD*)	CFA factor loadings	Item total correlation	Alpha if deleted	Cronbach's alpha (α)
Average (*M*) index	4.64	.97				
Lethal control (damage)						.86
It is acceptable for people to kill a black bear if they think it poses a threat to their property	2.57	1.44	.70	.71	.82	
Black bears should be killed if they have committed one offense of damaging crops	2.04	1.20	.85	.74	.81	
If a black bear causes damage to my property, it should be killed	2.15	1.21	.71	.72	.82	
Black bears should be killed if they have damaged crops multiple times	2.50	1.35	.79	.67	.84	
Average (*M*) index	2.32	1.09				
Lethal control (danger to self, pets, and economics)						.81
Black bears should be killed if they harass a neighbor's pet[d]	2.11	1.25	.87	.71	-	
Black bears should be killed if they kill a neighbor's pet[d]	2.64	1.67	.81	.71	-	
Average (*M*) index	2.38	1.37				

[a]Measured on a 4–point scale: "do not understand" (1), "slightly understand" (2), "moderately understand" (3), "fully understand" (4).
[b]Measured on a 6–point scale from "no risk at all" (1) to "very high risk" (6).
[c]Measured on a 7–point scale from "strongly disagree" (1) to "strongly agree" (7).
[d]Cronbach's alpha if item deleted was not available because of only two items.

Table 2. Respondents (n = 210) knowledge of black bear ecology and management facts by those with and without direct experience of seeing a black bear.

Correct response		Percent correct (%)[a]			χ^2-value	*p*-value	*φ*
Factual knowledge[b]		Direct experience	No direct experience	Total			
Black bear are native to Oregon	True	84	16	70	19.49	.001	.31
Black bears primarily eat meat	False	78	22	84	5.61	.018	.17
Black bears can legally be hunted in Oregon	True	85	15	54	14.22	.001	.26
Black bears are not good swimmers	False	78	22	71	2.52	.113	.11
Black bears have been known to peel the bark of young trees	True	80	20	63	4.22	.040	.14
Average (*M*) total[c]		3.67 (1.13 *SD*)	2.66 (1.54 *SD*)				

[a]Responses originally measured as "true" (1), "false" (2), and "unsure" (3). Recoded to "correct" (1) and "incorrect" (0) with "unsure" scored as incorrect. Cell entries are percentages of who got the answer correct (%).
[b]Correct responses/total responses: 0/5 (3%), 1/5 (6%), 2/5 (14%), 3/5 (20%), 4/5 (34%), 5/5 (22%).
[c]Represented the overall average (*M*) on five items answered correctly. The total number of correct responses (0–5) was used in the SEM (Figure 2).

Structural Model

Our hypothesized model fit the data well based on the criteria of fit (CFI* = .95, NNFI* = .94, IFI* = .95, RMSEA* = .04, χ^2 [471]/*df* [371] = 1.27). This SEM analysis did not involve any post hoc modifications. Direct experience was significantly related to all four antecedent dimensions of tolerance, with a positive association with connection (β = .32, $p < .05$) and a negative association with antipathy (β = −.31, $p < .05$), and both dimensions of lethal control (damage β = −.19; danger to self, pets, and economics β = −.29, $p < .05$). Risk perception was also significantly related to all four antecedent dimensions of tolerance, with a positive association with antipathy (β = .35, $p < .05$) and both dimensions of lethal control (damage β = .25, $p < .05$; danger to self, pets, and economics β = .24, $p < .05$), and a negative relationship with connection (β = −.33, $p < .05$). There was no significant relationship between direct experience and risk perception, so this hypothesis was not supported. Results also showed no significant relationships between factual knowledge and any antecedent dimension of tolerance. There were also no significant relationships between self-assessed knowledge and the two tolerance antecedent dimensions of antipathy and connection. Self-assessed knowledge was, however, positively related to both dimensions of lethal control (damage β = .26, $p < .05$; danger to self, pets, and economics β = .34, $p < .05$), instead of our hypothesized negative relationships. There was also a significant positive correlation between the two types of knowledge ($r = .35$, $p < .05$). Both self-assessed and factual knowledge were not related to risk perceptions. Significant positive relationships were found between direct experience and both types of knowledge. Direct experience was more strongly related to self-assessed knowledge (β = .54, $p < .05$, 29% variance explained) than factual knowledge (β = .29, $p < .05$, 8% variance explained).

Direct experience and risk perception explained 28% of the variance in antipathy and 20% of the variance in connection. Direct experience, risk perception, and self-assessed knowledge explained 11% of the variance in lethal control (damage) and 15% of the variance in lethal control (danger to self, pets, and economics). Correlations were significant ($p < .05$) among all four dimensions of tolerance.

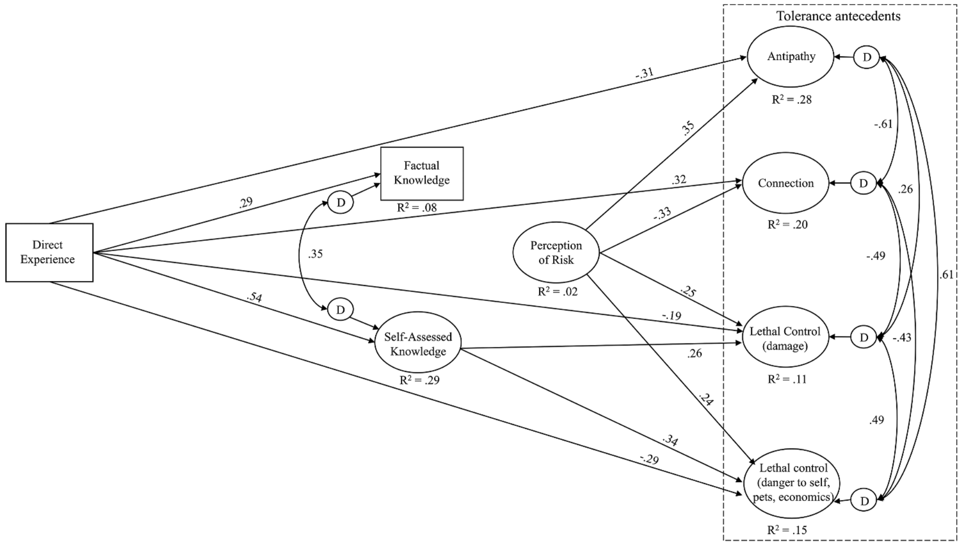

Figure 3. Structural equation model results. Only significant pathways are represented (p < .05), with standardized coefficients (ß). R2 is variance explained. Based on Satorra-Bentler robust estimation for multivariate non-normality, model fit indices: CFI* = .95, NNFI* = .94, IFI* = .95, RMSEA* = .04, χ^2 (471) /df (371) = 1.27.

Discussion

We examined predictors of a four antecedent dimensions of tolerance for black bears that included conceptualizations from the wildlife-related literature, and has been tested for reliability and construct validity in a prior study (see, Delie et al., 2022). Results from a sample population of recreational trail users indicated that direct experience, self-assessed knowledge, and perceived risk were either directly or indirectly related to each of the four antecedent dimensions of tolerance for black bears.

Predictors of Tolerance Antecedents

Direct experience in seeing a black bear was associated with all four antecedent dimensions of tolerance, although tolerance antecedents were not only related to direct experience. Direct experience and risk perception had almost equally strong relationships with the tolerance antecedent dimensions of antipathy (cost-related beliefs) and connection (benefit-related beliefs), but in opposing directions. As an individual's direct experience increased, their antipathy for bears decreased and their connection increased, but as risk perceptions increased, their antipathy increased and their connection decreased. This opposing relationship between these tolerance antecedent dimensions and both experience and risk perception are also supported by the negative correlation between antipathy and connection. Our results are consistent with research that has suggested direct experience with wildlife may be positively associated with connection and negatively related to antipathy by an individual perceiving an encounter with wildlife as a positive experience (e.g., Lischka et al., 2019). However, our findings also contradict studies such as Eriksson and Herberlein (2003), who found that direct experiences with wildlife perceived as dangerous (e.g., wolves) can make attitudes more negative. Although a main difference is their study measured multiple types of wildlife experiences, from seeing a wolf to having an animal killed by a wolf, whereas our study just asked trail users if they had ever seen a black bear in the wild. Respondents in our study who saw a black bear (whether running across a road or on a trail) may interpret their encounter as a positive direct experience versus someone who may have experienced a bear raiding a garbage container or felt threated. This difference between our studies in the measurement of direct experience may explain the inconsistent findings and suggests that the type of experience matters in understanding the role of experience and risk perception on tolerance antecedents.

Some direct experiences with wildlife can lead to humans becoming comfortable or conditioned to some species (Wilbur et al., 2018; Zinn et al., 2008). For example, Manfredo et al. (1998) found that Colorado residents who had direct encounters with mountain lions expressed less fear compared to residents who had no encounters. Given that the majority (75%) of respondents in our study reported having an experience of simply seeing a black bear and most of these respondents had a positive connection (M = 4.64), it was not surprising that they had relatively low antipathy, low risk perceptions, and less preference for lethal control. Alternatively, a large body of risk literature has evaluated how individual behaviors and cognitions can be changed by social and cultural communication, awareness, and concern about risk factors (e.g., Gore et al., 2005; Witte, 1992). Inskip et al. (2016), for example, found that people with more severe indirect negative experiences (e.g., stories, village-based tiger incidents) with tigers perceived greater risks than those with less severe or no indirect experiences. An individual could have read or their social and family group might have shared with them characteristics about wildlife such as a species being harmless or dangerous (Zinn et al., 2008), thereby contributing to one's perception of risk.

Contrary to our hypotheses, self-assessed knowledge was not associated with the tolerance antecedent dimensions of antipathy or connection. In addition, respondents with greater self-assessed knowledge were *more* likely to accept lethal control of black bears that cause damage or pose a threat to pets. One potential explanation for these results is that our measure of self-assessed knowledge tapped into a domain of knowledge about general black bear ecology and behavior that may be more familiar to individuals, such as hunters, who are typically more supportive of lethal control of wildlife generally (Naughton-Treves et al., 2003; Schroeder et al., 2018). Alternatively, Bandura (1986) explained that the greater the self-assessment of one's capabilities, the more vigorous and persistent their efforts are when faced with aversive experiences. If our self-assessed knowledge measure had included items about awareness of how to avoid unwanted or negative interactions with black bears, the self-assessment or perceived control (defined as beliefs about one's ability) among respondents may have increased, thus leading to different assessments of both risk and tolerance (Bruskotter & Wilson, 2014).

Research has shown that a topic's perceived importance can bias one's awareness of their own knowledge; the more important a topic is to an individual, the more likely they will view themselves as knowledgeable about that topic and be determined to rely on systematic processing (characterized by detailed, analytical thought about issue-relevant information) to reach a well-thought-out decision (Radecki & Jaccard, 1995). In this case, respondents assessed lethal control of black bears. Alternatively, other potential model factors that were not measured here, such as social identity (L. M. Van Eeden et al., 2020; Naughton-Treves et al., 2003; L. Van Eeden et al., 2019), may explain some relationships among direct experience, self-assessed knowledge, and preferences for lethal control. Human experiences can be mediated, in some part, by social group interactions and shared collective knowledge (Bandura, 1986). How a person interacts and self-categorizes with a group (e.g., bear hunter, livestock producer, biologist) can be directly associated with valuations of their own knowledge (Radecki & Jaccard, 1995) and indirectly with their tolerance, as individuals can affiliate their beliefs and attitudes with a group or engage in behaviors that affirm their identity to a group (e.g., purchasing hunting tags; Naughton-Treves et al., 2003).

Unlike self-assessed knowledge, our results showed that factual knowledge was not related to antecedent dimensions of tolerance or risk. This finding suggests that efforts to increase factual knowledge by providing scientific information (Flemming et al., 2018) and education to increase awareness (Arbieu et al., 2020; Knopff et al., 2016) may not be essential for reducing risk perceptions and increasing tolerance for wildlife. It is important to recognize, however, that the domain of factual knowledge measured in our study focused mostly on facts related to the ecology of black bears. Had we also included facts related to risk mitigation measures, such as known approaches to avoid negative interactions, factual knowledge may have been related to antecedents of tolerance and risk. Regardless, our results are consistent with the literature on the concept of knowledge, which has established that factual and self-assessed knowledge are distinct constructs (Bandura, 1986; Ladwig et al., 2012). Distinguishing factual from self-assessed knowledge shows levels of content understanding versus appraisal of one's own capabilities and self-confidence, respectively, and these can function differently in their associations with other cognitions and behaviors.

Another explanation for these results around knowledge may be that our sample included individuals who sought experiences in nature through outdoor recreation, suggesting they may have been attentive to environmental educational materials or had engaged in formal education or free-choice learning on the subject (Dietsch et al., 2018). Increasing a person's knowledge about topics such as wildlife biology and actions that one can take to avoid wildlife hazards in an area can actually heighten risk perceptions and lower tolerance (Slagle et al., 2013). In addition, Slagle et al. (2013) found that tolerance increased after communicating benefits of a species, such as the role of bears in a healthy ecosystem or the value of subsistence hunting, alongside communicating risks of interaction. Therefore, the type of content in educational materials can influence relationships among these concepts.

Implications for Outreach

Education alone is not a solution for solving human conflicts with wildlife and it rarely changes human behavior (Dietsch et al., 2018). This is consistent with most social science research that has largely discredited the "deficit model," which claims that people would think or behave differently if they simply understood or knew more about the issue (Allum et al., 2008). Our study showed that factual knowledge about bear ecology, whatever its other potential benefits, had little or no impact on the antecedent dimensions of tolerance for black bears. Instead, our results suggest that transforming knowledge into action requires opportunities for direct experience in which the feedback provided by these experiences can modify and refine beliefs, attitudes, expectations, knowledge, and skills (Bandura, 1986; Zinn et al., 2008). As a result, practitioners could use direct experience to expose people positively and safely to wildlife, thereby offering formative direct experiences in addition to indirect experiences that may promote tolerance. Although both these types of experiences can lead to greater factual knowledge, our model demonstrates that for the purposes of promoting tolerance, the greater benefits of direct experience by simply seeing a bear are through: (a) direct effects on antecedent dimensions of tolerance, and (b) the strengthening of self-assessed knowledge. Benefits of these experiences in cultivating tolerance stem not from their educational value in disseminating factual ecological knowledge, but from their direct and indirect effects on tolerance antecedents through people's assessment of their own knowledge and capabilities. Although hands-on learning is recognized by wildlife professionals as effective, practitioners often rely on printed or digital educational materials and community presentations due to limited resources to escort people into the field (Zinn et al., 2008). This recourse to information, aimed at increasing factual knowledge and thereby tolerance, may have limited utility in promoting human tolerance for wildlife and minimizing conflicts with wildlife, especially in the context of our study on black bears. More research on any possible links between factual knowledge and antecedents of tolerance can provide a clearer understanding of the learning conditions that influence tolerance toward wildlife.

Study Limitations

Given that our sample was specific to trail users, who are a small subset of Oregon's population that might interact with black bears, our results are not necessarily representative of a larger population. In addition, only 2–29% of the variance in concepts was explained by factors in our model; the remaining variance is explained by other concepts not explored here. This model variance could also be an outcome of how we conceptualized antecedents of tolerance as beliefs with four related scales compared to studies that approached tolerance for wildlife as either an attitude (e.g., Kansky et al., 2016) or an acceptance capacity (e.g., Lischka et al., 2019; Zajac et al., 2012). Some of our model items are like those used for measuring acceptance capacity (e.g., the antipathy item "I don't want any black bears in my community") and affect (e.g., the antipathy item "Black bears on my property make me uncomfortable"). Given that there are multiple different conceptualizations and measures of tolerance in the literature, the relationships among model concepts may be further understood by exploring other expressions of antecedents of tolerance for wildlife.

Researchers can build on our study by including other concepts and generalizing results to broader populations. For example, to understand the effects of multiple antecedent dimensions of tolerance on subsequent human behavior, researchers could approach our model through the framework of the cognitive hierarchy's principle of specificity from general to specific constructs (Fulton et al., 1996; Whittaker et al., 2006). The propensity to vote in opposition or support of a specific management action reflects a narrower context, action, and timeframe, and thus a more specific cognition, than many of the more general cognitive responses to an object (i.e., black bear) examined here. To some extent, social and institutional contexts guide specific behaviors, and to explore different cognitive antecedents of tolerance and subsequent behaviors, it may be necessary to study the governance structures and policies that support non-conflicting human interactions with wildlife (Bruskotter et al., 2015).

Despite our study addressing individual rather than societal level responses toward interactions with black bears, our findings provide a baseline for larger and more regional spatial comparisons of how people perceive this species. Our sampling approach starts to explore the social construction of space by collecting data across spatial environments (according to the density of documented human encounters with black bears) and in locations where people directly engage with nature (e.g., recreational trails). Improving our understanding of the contexts that may affect people's tolerance for interacting with wildlife can help answer the call to promote tolerance by offering more differentiated policy and adaptive management frameworks that consider regional and local contexts.

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