ABSTRACT

VAUGHN, AUDREY KATHERINE. Evaluating Implicit and Explicit Components of Human Attitudes Toward Snakes. (Under the direction of Dr. Lara Pacifici).

Human fear and antipathy toward snakes make conservation of this taxa difficult, as negative attitudes are not generally linked to public support. However, our understanding of the psychological mechanisms underlying human aversion to snakes is limited. We attempted to gain more insight into these psychological mechanisms by implementing two separate approaches aimed at evaluating both implicit and explicit components of attitudes toward snakes.

To gain insight into implicit biases related to snakes as well as whether human aversion to snakes is more innate or learned, respondents aged 7 to 76 completed an implicit association test (IAT) designed to examine implicit attitudes toward snakes. Parents had more negative implicit attitudes toward snakes than children, but we detected no effects for sex or race/ethnicity, and overall ability for demographic variables to predict implicit attitudes was low ($R^2 = 0.035$). Approximately 13% of overall variance was explained by the random effect for family unit ($\rho = 0.132$), indicating membership within a given household unit had small effects on the development of implicit biases against snakes. Collectively, these results support the hypothesis that human aversion to snakes is implicit and provide more evidence that aversion may be innate within our biological or cultural memory. Implicit bias training may be critical to mitigate the effects of negative implicit attitudes toward snakes. Although future research is needed to understand socio-demographic correlates of implicit biases against snakes, our results indicate interventions may be crafted without concern about unique responses to snakes across sex and ethnicities.

To better understand explicit components of human aversion to snakes and expand our knowledge to parts of the southeastern U.S., we distributed an online questionnaire and collected

responses from 743 undergraduate students at North Carolina State University (NCSU). We incorporated measures of various demographic and social-psychological variables and ultimately used these variables to predict tolerance toward snakes. Tolerance of snakes varied based on whether the snake was venomous, non-venomous, or unidentified. Students were much more likely to kill venomous snakes than those that are non-venomous. Social-psychological variables, including value orientations and emotions, represented key predictors of whether a respondent would kill a snake. More specifically, stronger dominionistic scores and weaker mutualistic scores were correlated with a greater tendency to kill a snakes in all three scenarios. Further, lower valence scores signified a greater tendency to kill both venomous and non-venomous snakes. Although demographics were less important in directly predicting behavioral intentions, we argue that in some cases, demographic variables act as moderators that indirectly influence an individual's tolerance toward snakes. We suggest that wildlife value orientations and emotions represent critical components in determining how people react to wildlife and that some demographic variables may act as moderators in determining tolerance toward snakes.

Evaluating Implicit and Explicit Components of Human Attitudes Toward Snakes

by
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DEDICATION

To my sister Allie and mother Susan, who have been unrelenting positive forces in my life for as long as I can remember, and to my chosen family—my incredible friends—Syd, Somer, Emily, Lauren, and so many more, thank you for your love, support, and encouragement in everything that I do. Finally, to my nephews Clark and Griffin, who hold a place in my heart I did not know was there. In the coming years, I hope you will both be inspired by the natural world and everything that it offers.

BIOGRAPHY

Audrey was born in Atlanta, GA, where she lived until she moved to Athens, GA to pursue an undergraduate degree. In 2017, Audrey graduated from the University of Georgia with a BS in Fisheries and Wildlife. During her time as an undergraduate student, she was able to participate in wildlife outreach projects, write a senior thesis, and study wildlife in Botswana and South Africa. After graduating, she worked at Oklahoma State University as a collared lizard research technician before moving back to Atlanta and working as a veterinary technician and environmental educator. She has always been most interested in studying and teaching about herpetofauna, specifically reptilian species. In 2019, she moved to Raleigh, NC to pursue her MS in Fisheries, Wildlife, and Conservation Biology. After graduation, Audrey hopes to work for a government agency or non-profit organization focused on wildlife conservation and management.

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CHAPTER 1: Introduction

Biodiversity conservation conflicts are becoming increasingly prevalent as the human population expands (Dickman, 2010), and such interactions have important implications for wildlife conservation practices (Kansky et al., 2016). Human attitudes toward wildlife and subsequent behaviors can have lasting impacts on the efficacy of conservation and management initiatives and in turn play a key role in determining whether certain wildlife populations persist or decline (Liordos et al., 2017). As such, there is a growing body of literature aimed at evaluating the psychological mechanisms underpinning human attitudes toward wildlife species and how such attitudes result in actions that may either hinder or support certain efforts (Keener-Eck, 2009). This research may be particularly important for commonly feared or disliked species that are unable to garner the same degree of public support when compared with more charismatic, well-liked wildlife (Kellert & Berry, 1980; Knight, 2008; Batt, 2009).

Snakes have long been objects of intense dread and contempt among humans (Öhman & Mineka, 2003; Pandey et al., 2016; Kawai, 2019) and have consistently been ranked as some of the most disliked animals globally (Šurinová, 1971; Kellert & Berry, 1980, 1982; Batt, 2009). Despite the fact that snakes benefit humans by acting as ecological indicators (Mullin & Seigel, 2009; Ceríaco, 2012), facilitating rodent control (Pandey et al., 2016), offering opportunities for medicinal advances (da Nóbrega Alves et al., 2008; Vyas et al., 2013), and providing various goods such as food and raw materials (Ceríaco, 2012), negative public perceptions of snakes stemming from intense fear, disdain, and misunderstanding are prevalent (Fredrikson et al., 1996; LoBue & DeLoache, 2008; Burghardt et al., 2009; Souchet & Aubret, 2016). Such negative attitudes have led to a disproportionate lack of funding for snake conservation efforts when compared with more charismatic, well-liked species (Kaltenborn et al., 2006; Martín-

López et al., 2007; Prokop et al., 2009; Sitas et al., 2009; Ballouard et al., 2013). Further, snakes are often intentionally killed by humans (Czech et al., 1998; Bonnet et al., 1999; Christoffel, 2007; Crawford & Andrews, 2016). These combined factors are thought to contribute to continuing global population declines among many snake species (Gibbons et al., 2000; Prokop et al., 2009). Accordingly, the effectiveness of snake conservation and management efforts depends in large part on improving our understanding of human dispositions and behaviors toward snakes (Gibbons, 1988; Ceríaco, 2012; Torkar, 2015). Despite the key role that public perceptions of snakes play in conservation and management practices, attitudes toward reptiles such as snakes are underrepresented in human dimensions research (Bonnet et al., 2002; Christoffel & Lepczyk, 2012). This gap in our knowledge necessitates additional research aimed at better understanding human attitudes toward snakes.

Negative attitudes toward snakes may include both implicit and explicit components, which can coexist in one's memory but may be inconsistent with one another (Manfredo, 2008). Attitudes can be defined as "association(s), in memory, of an evaluation with an object" (Fazio et al., 1982, p. 341). Explicit attitudes are evaluative appraisals that require active cognitive engagement (Gawronski & Bodenhausen, 2006; Manfredo, 2008), while implicit attitudes emerge outside of conscious awareness as a result of associative learning and lead to long-lasting, stable knowledge (Greenwald & Banaji, 1995; Smith & DeCoster, 2000; Wilson et al., 2000; Gawronski & Bodenhausen, 2006; Manfredo, 2008). According to Field (2006), associative learning occurs when a stimulus, such as an animal, is consistently paired with a negative evaluation (e.g., 'that animal bites'). The vast majority of research on public perceptions of snakes has focused on explicit attitudes (Yorek, 2009; Fita et al., 2010; Ceríaco, 2012; Ballouard et al., 2013; Torkar, 2015; Pandey et al., 2016; Liordos et al., 2018), which are

generally easier to measure and involve self-report questionnaires and interviews (Manfredo, 2008). However, in order to fully understand how humans might respond to wildlife, we need knowledge about both implicit and explicit attitudes (Rudman, 2004; Purkis & Lipp, 2007; Manfredo, 2008).

Research Objectives and Thesis Format

This thesis is written in manuscript format. The first (and present) chapter introduces the context surrounding and overarching theme of this research. Chapters two and three are written as independent manuscripts that will be submitted for publication. Considering this larger research context, our research objectives in those chapters are as follows:

CHAPTER 2 — USING THE IMPLICIT ASSOCIATION TEST TO EVALUATE IMPLICIT ATTITUDES TOWARD SNAKES

1. Provide the first assessment of IATs among a diverse population
2. Provide the first assessment of IATs for snakes among children
3. Provide the first assessment of how IATs for snakes co-vary within households

CHAPTER 3 — PREDICTING U.S. UNDERGRADUATE STUDENTS' PERCEPTIONS AND TOLERANCE OF SNAKES

1. Characterize students' past experience with snakes and demographic correlates
2. Determine students' knowledge of snakes, including both natural history and identification knowledge, and demographic correlates
3. Identify students' value orientations toward snakes and demographic correlates
4. Identify students' affective attitudes toward snakes and demographic correlates

5. Measure students' tolerance (i.e., behavior intentions) for venomous and non-venomous snakes and identify demographic and social-psychological correlates of tolerance.

Throughout the discussion section of each paper, we highlight important limitations as well as broader implications for research as well as practice.

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CHAPTER 2: Using the implicit association test to evaluate subconscious attitudes toward snakes

Abstract

Human fear and antipathy toward snakes make conservation and management of these species difficult, as negative attitudes are not generally linked to public support. However, our understanding of whether such attitudes are innate or learned is limited. In this study, respondents aged 7 to 76 completed an implicit association test (IAT) designed to examine implicit attitudes toward snakes. Parents had more negative implicit attitudes toward snakes than children, but we detected no effects for sex or race/ethnicity, and overall ability for demographic variables to predict implicit attitudes was low ($R^2 = 0.035$). Approximately 13% of overall variance was explained by the random effect for family unit ($\rho = 0.132$), indicating membership within a given household unit had small effects on the development of implicit biases against snakes. Collectively, these results support the hypothesis that human aversion to snakes is implicit and provide more evidence that aversion may be innate within our biological or cultural memory. Implicit bias training may be critical to mitigate the effects of negative implicit attitudes toward snakes. Although future research is needed to understand socio-demographic correlates of implicit biases against snakes, our results suggest interventions may be crafted without concern about unique responses to snakes across sex and ethnicities.

Introduction

Snakes are generally met with antipathy despite serving a variety of important ecological and utilitarian purposes for humans. Snakes benefit humans by acting as ecological indicators (Mullin & Seigel, 2009; Ceríaco, 2012), facilitating rodent control (Pandey et al., 2016), offering opportunities for medicinal advances (da Nóbrega Alves et al., 2008; Vyas et al., 2013), and

providing various goods such as food and raw materials (Ceríaco, 2012). Despite these benefits, humans tend to treat snakes with hostility, contributing to continuing global population declines among many snake species (Gibbons et al., 2000; Prokop et al., 2009). Negative public perceptions of snakes associated with intense fear, disdain, and misunderstanding serve as the foundation for persecution of snakes (Fredrikson et al., 1996; LoBue & DeLoache, 2008; Burghardt et al., 2009; Souchet & Aubret, 2016). Despite the fact that the probability of dying from a snake bite in the United States is close to zero (Morgan et al., 2004; Langley et al., 2014; Chippaux, 2017), several studies suggest fear of snakes is the most prevalent animal phobia among Americans (Agras et al., 1969; Mittermeier et al., 1992; Thorpe & Salkovskis, 1997). Snakes have consistently ranked as among the most disliked animals globally (Šurinová, 1971; Kellert & Berry, 1982). Such negative attitudes toward snakes have led to a disproportionate lack of funding for snake conservation efforts when compared with more charismatic, well-liked species (Kaltenborn et al., 2006; Martín-López et al., 2007; Prokop et al., 2009; Sitas et al., 2009; Ballouard et al., 2013). Further, snakes are often intentionally killed by humans (Czech et al., 1998; Bonnet et al., 1999; Christoffel, 2007; Crawford & Andrews, 2016). Accordingly, the effectiveness of snake conservation and management efforts depends in large part on improving our understanding of human dispositions and behaviors toward snakes (Gibbons, 1988; Ceríaco, 2012; Torkar, 2015).

Negative attitudes toward snakes may have both evolutionary and learned elements (Kawai, 2019). The origins of snake fear have been traced back to early mammalian evolution when large constrictors presented a significant threat to survival, leading to avoidance behavior in order to reduce snake-induced mortality (Isbell, 2006; Souchet & Aubret, 2016). Isbell et al. (2006, 2009) suggest an evolutionary arms race between snakes and mammals led to the

evolution of orbital convergence, as well as visual and brain specialization, among primates. The non-associative view of fear acquisition suggests humans have an *innate* fear of snakes (Menzies & Clarke, 1995), emerging "without any relevant associative learning experiences" (Poulton & Menzies, 2002, p. 128). This theory posits that natural selection favored individuals who reacted with some degree of fear upon their first encounter with dangerous snakes (Poulton & Menzies, 2002). Support for the non-associative view of fear acquisition was presented by Shibasaki and Kawai (2009) when they demonstrated lab-reared, snake-naïve macaque monkeys (*Macaca fuscata*) identified photos of snakes in an array of flower photos more quickly that they did vice versa.

Although some innate fear of snakes seems likely, so does a socially learned fear of snakes (Cook & Mineka, 1987, 1989; Öhman & Mineka, 2001, 2003; DeLoache & LoBue, 2009). Seligman's (1970) prepared learning theory suggests humans have evolved a predisposition to *learn* their fear of snakes (Öhman & Mineka, 2001, 2003). The most compelling evidence for this theory comes from research on nonhuman primates. Several studies indicate lab-reared rhesus monkeys (*Macaca mulatta*) and squirrel monkeys (*Saimiri sciureus*) exhibit little to no fear of snakes compared to wild-reared monkeys, suggesting that those that grew up in the wild acquired their fear of snakes through learned experiences (Joslin et al., 1964; Murray & King, 1973; Mineka et al., 1980). Cook and Mineka (1989) strengthened support for this argument by demonstrating that lab-reared rhesus monkeys developed an intense, persistent fear of snakes simply by observing the fearful reactions of wild monkeys to both live and toy snakes.

Negative attitudes toward snakes may include both explicit and implicit components, which can coexist in one's memory but may be inconsistent with one another (Manfredo, 2008).

Attitudes can be defined as "an association, in memory, of an evaluation with an object" (Fazio et al., 1982, p. 341). Explicit attitudes are evaluative appraisals that require active cognitive engagement (Gawronski & Bodenhausen, 2006; Manfredo, 2008). The vast majority of research on public perceptions of snakes has focused on explicit attitudes (Yorek, 2009; Fita et al., 2010; Ceríaco, 2012; Ballouard et al., 2013; Torkar, 2015; Pandey et al., 2016; Liordos et al., 2018), which are generally easier to measure and involve self-report questionnaires and interviews (Manfredo, 2008). However, in order to fully understand how humans might respond to wildlife, we need knowledge about both explicit and implicit attitudes (Rudman, 2004; Purkis & Lipp, 2007; Manfredo, 2008). Implicit attitudes emerge outside of conscious awareness as a result of associative learning and lead to long-lasting, stable knowledge (Greenwald & Banaji, 1995; Smith & DeCoster, 2000; Wilson et al., 2000; Gawronski & Bodenhausen, 2006; Manfredo, 2008). According to Field (2006), associative learning occurs when a stimulus, such as an animal, is consistently paired with a negative evaluation (e.g., 'that animal bites').

Implicit attitudes are challenging to measure because they require tests with the ability to assess subconscious phenomena (Manfredo, 2008). The most popular approach for measuring implicit attitudes, the implicit association test (IAT), records the amount of time it takes for respondents to correctly categorize stimuli into the appropriate categories (Greenwald et al., 1998). The IAT operates under the assumption that the speed and accuracy with which a respondent classifies a stimulus into the correct category reflects the degree to which these concepts are associated in their memory (Nicholson & Barnes-Holmes, 2012). In other words, the IAT treats faster response times for positive pairings as indicative of positive implicit attitudes, and vice versa (Greenwald et al., 1998; Manfredo, 2008). Although the IAT has traditionally been used in projects evaluating implicit biases toward race and gender (Rudman et

al., 1999; Ottaway et al., 2001; Teachman et al., 2001), one study has used the IAT to assess adult implicit attitudes toward snakes and spiders (Teachman et al., 2001), and another with bears and wolves (Flykt et al., 2013). Teachman et al. (2001) found strong relationships between explicit (self-identified as snake fearful) and implicit attitudes toward snakes among Yale students, but did not focus on the roots of these biases. It is important to note that the IAT is an imperfect tool. For instance, the IAT's ability to predict specific behaviors has been called into question (Gawronski, 2019).

No research has addressed how implicit wildlife attitudes vary within and among family units, but these relationships may shed light on the degree to which attitudes toward snakes are learned. Family units represent cultural entities, where attitudes are fostered and shared (Vollebergh et al., 2001; Clark et al., 2017). Some families may have more positive attitudes toward snakes than others, particularly if implicit attitudes towards snakes are learned. Further, generational groups may display developmental and attitudinal trends (Morris & Morris, 1965), as youth are still forming attitudes and older adults already have stable attitudes even in cases where attitudes emerge from socialization (Vollebergh et al., 2001; Clark et al., 2017). If the roots of implicit attitudes toward snakes is evolutionary, we may expect little variation across age groups. Accordingly, similarities across families and age groups would point to strong evolutionary roots of implicit attitudes, whereas variation between family units and across age ranges would point to learned aspects. Although the role of parental behaviors in dictating the development of their children's psychological characteristics can be smaller than the role of other social groups outside the home (Plomin, 1990; Harris, 1995; Fishbein, 2002), significant associations between implicit attitudes among parents and their children exist for race (Castelli et al., 2009). Mothers' implicit biases regarding race were strongly associated with children's

attitudes, suggesting "involvement in the socialization process of the children might thus be an important moderator in the transmission of attitudes" (Catelli et al., 2009, p. 590). Similarly, the degree to which a child identifies with their parent might play an important role in the formation of their intergroup attitudes (Sinclair et al., 2005). Although there is little research addressing how attitudes toward wildlife vary among and within households, emerging studies suggest children report their parents as playing a significant role in influencing the formation of their attitudes toward wildlife (Pomerantz, 1977; Aslin & Bennett, 2000), and wildlife value orientations are driven in part by membership in household units (Clark et al., 2017).

In this study, we begin addressing the need for a more comprehensive understanding of implicit attitudes toward snakes with a case study comparing implicit attitudes among household units and across a broad age range. Importantly, this study does not attempt to measure explicit attitudes or ophiophobia, but instead focus solely on measuring implicit biases. We hypothesized that (1) respondents would demonstrate a negative implicit bias toward snakes across all demographic variables, (2) parents would demonstrate more negative implicit bias toward snakes than children, and (3) implicit bias toward snakes would be associated with household unit. Hypothesis 1 is based on explicit attitude studies indicating that snakes are among the most heavily feared and disliked animals (Šurinová, 1971; Kellert & Berry, 1982; Mittermeier et al., 1992). Hypothesis 2 emerges from the theory that negative perceptions toward commonly feared animals such as snakes are not entirely innate and involve a learned component (Seligman, 1970; Murray & King, 1973; Mineka et al., 1980; Cook & Mineka, 1989). Hypothesis 3 emerges from studies suggesting membership within a household unit plays a role in the development of children's attitudes toward wildlife (Clark et al., 2017). This research contributes to knowledge about implicit attitudes toward snakes in three key ways: providing the first assessment of IATs

among a diverse population, providing the first assessment of IATs for snakes among children, and providing the first assessment of how IATs for snakes co-vary within households. These contributions are important in advancing our understanding of human-snake relationships which may in turn aid in developing more effective conservation and management.

Methods

Sampling

Data was collected between February and April 2020 using a stratified convenience sample. We sampled 175 individuals, including 87 parents and 88 children. In all cases, respondents completed the IAT on either their own computer or a computer provided by the interviewer. Because data collection spanned emergence of the COVID-19 pandemic, we started data collection in-person (n = 86; February 27th through March 22nd) and finished with online data collection (n = 89; March 23rd through April 9th). When online data collection started, we delivered directions for completing questionnaires and IATs via email and provided live instruction using Zoom. To check for mode effect, we compared implicit biases between pre-COVID and post-COVID sampling events using an independent samples *t*-test and did not detect a significant difference (p = 0.57).

Questions

We measured respondent implicit associations with snakes relative to their implicit associations with songbirds. We used *FreeIAT software*, a free open-source alternative to commercial implicit association tests, to administer IATs (Meade, 2009). Participants were presented with a welcome screen outlining the various stimuli that would be presented, the categories into which they should classify those stimuli, and the keyboard commands to navigate the software. Following the welcome page, respondents were presented with five trials where

they would classify the stimuli into the appropriate categories using the pre-defined keyboard commands. Three of the trials were used for training participants, while the other two trials were used to generate data. For the two data-generating trials, either pictorial stimuli (photo of one of ten snake species native to NC or photo of one of ten bird species native to NC; Appendix 1), or word stimuli (positive words; e.g., good, joy, love, peace, wonderful, pleasure, happy, or negative words; e.g., bad, agony, terrible, horrible, nasty, evil, awful, failure; Appendix 1) were presented in the center of the screen (Figure 2.1). The positive and negative word stimuli were obtained from a default list within the IAT software program. Participants were then asked to assign stimuli to one of two category pairs presented in the upper right and upper left corners of the screen (Figure 2.1). Category pairs consisted of the word "snakes" or "songbirds" combined with the descriptor category of positive words or negative words (Figure 2.1). Respondents had to quickly decide which category the stimuli belonged to and press the appropriate key to classify and move on to the next stimulus. A large X appeared if the respondent answered incorrectly and the screen did not change until the correct response was chosen. Each trial presented respondents with 20 stimuli to categorize, and the IAT software recorded the amount of time it took to categorize each stimulus.

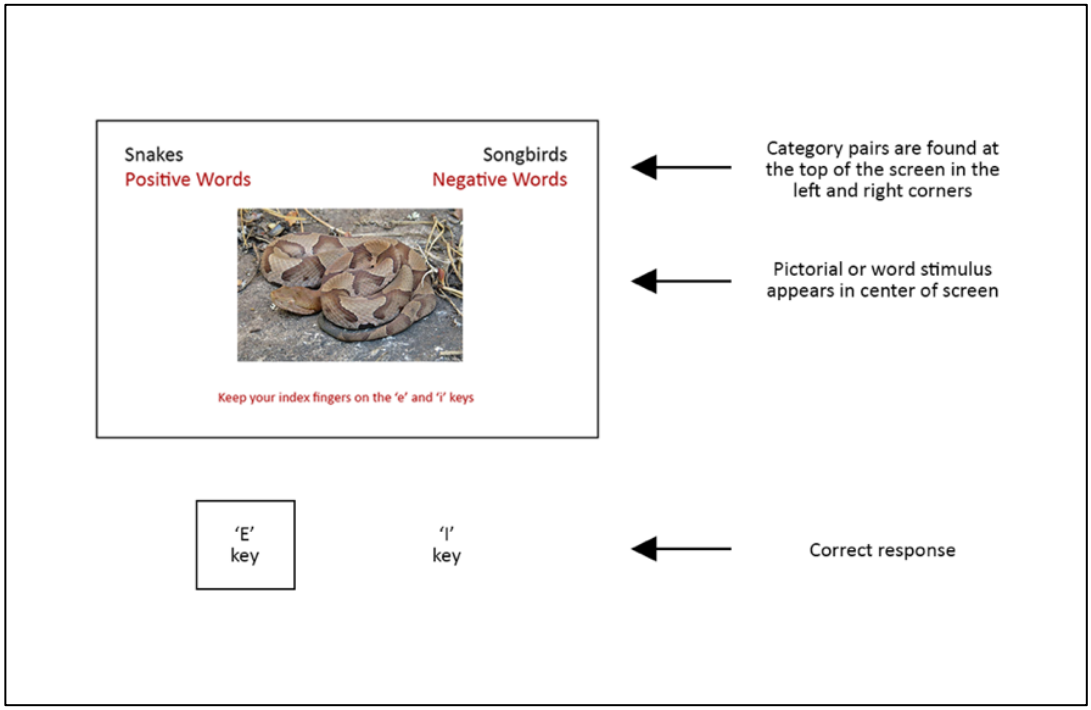

Figure 2.1. Schematic depiction of IAT procedure.

The first trial was an image training round, where respondents practiced classifying snake/bird images into snake and bird categories (i.e., the categories only read "snakes" or "songbirds"). The second trial was a word training round, where respondents practiced classifying positive/negative word stimuli into positive/negative word categories (i.e., the categories only read "positive words" or "negative words"). The third trial merged the first two trials by combining the categories and the stimuli. That is, one side of the screen read "snakes/positive words" and the other side read "songbirds/negative words", as seen in Figure 2.1. Then, images or words appeared as stimuli and respondents sorted the stimuli into the appropriate category. Trial four was a reverse image training trial in which respondents were presented with photo stimuli of either snakes or songbirds and were asked to categorize them appropriately, but the "snake" and "songbird" categories were in opposite corners of the screen than in trial one. Trial five was the second paired test trial, similar to trial three, but the "snakes"

category was paired with the "negative words" category and "songbirds" with "positive words". In addition to the IAT, we asked each respondent to report their age, sex, and race/ethnicity.

Data Analysis

We calculated the mean Greenwald, Nosek, and Banaji (GNB) score from IATs by subtracting the mean corrected response time in trial three from the mean corrected response time in trial five (Greenwald et al., 2003). Given trial five had categories that matched dominant attitudes towards snakes and songbirds (positive words and songbirds versus negative words and snakes) and trial three had mismatched categories (positive words and snakes versus negative words and songbirds), lower GNB scores indicate stronger implicit biases against snakes relative to songbirds.

We used summary statistics to determine average GNB score across all respondents (hypothesis 1). We then modeled GNB scores using multilevel modeling with family role (parents versus children; hypothesis 2), sex (male versus female), and race or ethnicity (White versus Person of Color) acting as fixed independent variables and with a random effect for household unit (hypothesis 3). The household unit random effect represents the likelihood that individuals residing in the same household may have similar GNB scores. These predictors were entered simultaneously within our model. We used the intraclass correlation coefficient (ICC), or rho, to determine what proportion of the total variance could be attributed to the random household unit variable (Bala & Prada, 2014; Clarke et al., 2017; Nakagawa et al., 2017).

Results

The sample (n = 175) reflected the stratified sampling strategy in terms of parents versus children (49.7% parents). Number of parents and children differed because we did not require all household units to include the same number of parents and children. Parent ranged in age from

21 to 76 (M = 44.6), while children ranged from 7 to 17 (M = 13.0). The sample was also split relatively evenly between those identifying as male (48%) and female (50.9%). Most participants (77.1%; n = 135) identified as White. Hypothesis 1 was supported by an overall negative average GNB score across all respondents (M = -0.23, SD = 0.40), though scores ranged from -1.18 to 0.60 with a relatively normal distribution. Aversion to snakes was expressed without conscious, cognitive processing in the majority (68%) of our respondents. Additionally, average GNB scores were negative across all demographic groups, including parents (M = -0.30, SD = 0.42) and children (M = -0.16, SD = 0.37), males (M = -0.24, SD = 0.41) and females (M = -0.23, SD = -0.40), and Whites (M = -0.24, SD = 0.42) and People of Color (M = -0.19, SD = 0.36).

Hypothesis 2 was supported by regression estimates which indicated the mean GNB score was significantly more negative for parents than for children (Table 1), with parents having twice as strong a negative score (M = -0.30, SD = 0.42) as children (M = -0.16, SD = 0.37). However, we did not detect a relationship between GNB scores and sex or race/ethnicity (Table 1). Our findings also supported hypothesis 3: household unit played a role in predicting GNB score. The rho value derived from regression estimates ($\rho = 0.132$, Table 2.1) indicated that the random effect variable for household unit accounted for approximately 13% of the variance explained by our GNB score model. However, the overall variance explained by the model was low ($R^2 = 0.035$), suggesting limited impacts of demographic variables on GNB scores.

Table 2.1. Linear regression predicting GNB score based on parent vs. child, sex, race/ethnicity, and household membership.

Variable	**B**	***SE***	**β**	***p***
Parent vs. Child [1]	0.138	0.057	0.171	0.016*
Sex [2]	0.010	0.059	0.013	0.860
Race/Ethnicity [3]	0.038	0.079	0.040	0.629
R^2	0.035			
Rho	0.132			

[1] Dummy variable: 0 if parent, 1 if child
[2] Dummy variable: 0 if male, 1 if female
[3] Dummy variable: 0 if White, 1 if Non-White

Discussion

Our results suggest that learning and socialization may play a role in the development of negative attitudes toward snakes, but these attitudes may be better explained by evolutionary processes that have led to an innate fear of these animals. The negative average GNB score across all respondents and within each of the demographic groups in our study supports the idea that implicit components to human aversion toward snakes exist. Furthermore, our model suggests that very little of the variance in negative biases could be explained by generational differences, sex, or race/ethnicity. When combined, these findings suggest human aversion toward snakes may be more innate than learned and lend support for the non-associative model of fear acquisition, which posits that humans have an innate predisposition for some fears that do not require conditioning or learning but are instead products of natural selection (Rachman, 2002; Purkis & Lipp, 2007). Positive implicit attitudes toward snakes seen among some individuals in our study may be attributed to genetic variability (Öhman & Mineka, 2003) or the possibility that these individuals have learned to *not* fear snakes over time (Menzies & Clarke, 1995; DeLoache & LoBue, 2009).

Although independent variables in our model explained little variance in negative IAT associations with snakes, the average GNB score for parents was almost twice as negative as it was for children. These results provide some support for the idea that generational differences exist in implicit biases toward snakes. Thus, human aversion to snakes may involve learning over time. This interpretation aligns with previous studies on nonhuman primates where laboratory-reared monkeys learned to fear snakes after watching the fearful reactions of wild-reared monkeys (Cook & Mineka, 1989). An overall shift in wildlife-related values where younger generations have more mutualistic and positive orientations toward wildlife than older

generations may also explain generational differences in GNB scores (Manfredo & Zinn, 1996; Clark et al., 2017). These differences in orientations related to explicit attitudes found in previous studies may be associated with underlying implicit attitudes. This interpretation, however, should be approached with caution since most associated research focuses on adults of different ages rather than comparing adults with children (Manfredo & Zinn, 1996; Vaske et al., 2011; Gamborg & Jensen, 2016).

Membership within a given household unit did predict implicit attitudes toward snakes, but this effect was relatively weak. Although, to our knowledge, this study is the first to evaluate the extent to which implicit biases toward snakes can be explained by family unit membership, previous research has documented household effects on explicit wildlife attitudes and wildlife value orientations (Zinn et al., 2002; Clark et al., 2017). Collectively, these findings serve to highlight the persistent role of household or family-based socialization on how humans orient themselves explicitly and implicitly toward wildlife. Socialization outside of the family unit (e.g., with peers), which has not been considered here, may also impact implicit attitudes toward snakes (Harris, 1995; Fishbein, 2002).

Not detecting a relationship between implicit attitudes and sex or race/ethnicity contradicted some previous studies. For instance, past research demonstrates that females tend to exhibit greater explicit fear of snakes and lower snake tolerance when compared with males (Fredrikson et al., 1996; Prokop et al., 2009; Rakison, 2009; Liordos et al., 2017). Although there is a lack of research addressing differences in aversion to snakes and other wildlife based on race/ethnicity, Kellert et al. (2017) found that Black, Asian, and Hispanic respondents were significantly more likely than White respondents to indicate that the world would be better off without dangerous wildlife. Other studies have indicated that fear of certain animals differs based

on race/ethnicity, with White participants often exhibiting lower animal-related phobias than other groups (Burnham & Lomax, 2009; Kellert et al., 2017). Additionally, some studies have demonstrated substantial differences in other environmental concepts, such as constraints to outdoor recreation (Shores et al., 2007; Bustam et al., 2011; Parker & Green, 2015), between various racial groups. On the other hand, more recent studies suggest that sex and race may not play as large a role in environmental engagement and development of environmental attitudes as we previously thought, once personal experiences are accounted for (Szczytko, 2017; William, 2017). The lack of association between implicit attitudes toward snakes and sex or race/ethnicity may have two other explanations. First, implicit attitudes may be different than explicit attitudes, with snakes eliciting such strong negative responses among all people that demographic differences are relatively insignificant. Second, the relatively small sample size in this study may have resulted in small effects difficult to detect.

Future research expanding the understanding of wildlife IATs, particularly snake related IATs, is essential because human responses to wildlife are in large part a result of implicit biases toward these animals (Manfredo, 2008), and these implicit biases drive discriminatory behaviors (Levy, 2015). Future researchers should aim to incorporate a larger and more diverse group of respondents. Doing so would strengthen inference associated with non-significant variables and allow for inclusion of additional variables such as rural versus urban residence, political affiliation, and past experiences that may play a role in determining implicit biases toward snakes. Researchers might also consider measuring both explicit and implicit attitudes toward snakes among both children and adults within a single study, which would present opportunities to compare the relationship between the two.

This study suggests wildlife conservation practitioners may benefit from adopting practices used by social justice advocates to mitigate the effects of negative implicit attitudes. Interventions such as implicit bias training have been designed based on the assumption that implicit biases are analogous to habits and "can be reduced through a combination of awareness of implicit bias, concern about the effects of that bias, and the application of strategies to reduce bias" (Devine et al., 2012, p. 1267). Many institutions (e.g., police departments) use implicit bias training to reduce racism and other forms of prejudice against specific groups of people (Jackson, 2018; Applebaum, 2019). Similar strategies may be applied to implicit biases toward commonly feared or disliked wildlife such as snakes. Although implicit biases are difficult to change due to their long-lasting, stable nature (Vuletich & Payne, 2019), making people aware of their implicit attitudes may be the first step in mitigating behaviors or beliefs that are detrimental to snakes.

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CHAPTER 3: Factors associated with undergraduate students' perceptions and tolerance of snakes

Abstract

Snakes are controversial animals, often inciting fear and disdain among the public. Understanding human perceptions of and subsequent behaviors toward snakes is an important component of effectively conserving these animals. Here, we investigate attitudes toward snakes through an online questionnaire, collecting responses from 743 undergraduate students at North Carolina State University (NCSU). We incorporated measures of various demographic and social-psychological variables and ultimately used these variables to predict tolerance toward snakes. Tolerance of snakes varied based on whether the snake was venomous, non-venomous, or unidentified. Students were much more likely to kill venomous snakes when compared with non-venomous. Social-psychological variables, including value orientations and emotions, represented key predictors of whether a respondent would kill a snake. More specifically, stronger dominionistic scores and weaker mutualistic scores were correlated with a greater tendency to kill a snakes in all three scenarios. Further, lower valence scores signified a greater tendency to kill both venomous and non-venomous snakes. Although demographics were less important in directly predicting behavioral intentions, we propose that in some cases, demographic variables act as moderators that indirectly influence an individual's tolerance toward snakes. We suggest that wildlife value orientations and emotions represent critical components in determining how people react to wildlife and that some demographic variables may act as moderators in determining tolerance toward snakes.

Introduction

Snakes benefit the natural environment and humans in many ways. In addition to playing key roles in trophic systems and serving as important ecological indicators (Mullin & Seigel, 2009; Ceríaco, 2012), snakes also protect agricultural products and mitigate disease transmission by controlling rodent populations (Pandey et al., 2016; Onyishi et al., 2020, in press). Furthermore, snakes provide opportunities for medicinal advancement via development of therapeutic drugs using venom (Vyas et al., 2013; Waheed et al., 2017). They also support the production of various goods such as food (Klemens & Thorbjarnarson, 1995) and raw materials such as cosmetics and clothing (Ceríaco, 2012; Ijeomah et al., 2017).

Despite these benefits, humans often treat snakes with hostility and animosity, contributing to global population declines among many snake species (Gibbons et al., 2000; Prokop et al., 2009). Negative public perceptions of snakes associated with intense fear, disdain, and misunderstanding serve as the foundation for persecution of snakes (Fredrikson et al., 1996; LoBue & DeLoache, 2008; Burghardt et al., 2009; Souchet & Aubret, 2016; Rádlová et al., 2019). Although the probability of dying from a snake bite in the United States is close to zero (Morgan et al., 2004; Langley et al., 2014; Chippaux, 2017), several studies suggest fear of snakes is the most prevalent animal phobia among Americans (Agras et al., 1969; Mittermeier et al., 1992; Thorpe & Salkovskis, 1997). Further, snakes have consistently ranked as among the most disliked animals globally (Šurinová, 1971; Kellert & Berry, 1982). The effectiveness and success of snake conservation and management efforts are often limited by such negative perceptions, with the majority of resources being allocated to larger, more charismatic species instead (Czech et al., 1998; Kaltenborn et al., 2006; Martín-López et al., 2007; Prokop et al., 2009; Ceríaco, 2012; Torkar, 2015). Furthermore, snakes often face active persecution by

humans in the form of intentional killings, which in some cases may represent a substantial portion of overall mortality and subsequent population declines among snakes (Dodd, 1987; Bonnet et al., 1999; Gibbons et al., 2000; Whitaker & Shine, 2000; Christoffel, 2007; Balakrishnan, 2010; Crawford & Andrews, 2016; Pandey et al., 2016).

Given the ecological and utilitarian value of snakes, and in light of growing threats to their persistence, a better understanding of human attitudes toward snakes and how attitudes lead to behaviors is needed to effectively guide conservation and management efforts (Gibbons, 1988; Gibbons et al., 2000; Prokop et al., 2009; Dickman, 2010; Ceríaco, 2012; Flykt et al., 2013; Treves & Bruskotter, 2014; Torkar, 2015; Liordos et al., 2018; Struebig et al., 2018). More specifically, the psychological mechanisms that encourage or suppress tolerance for these animals should be explored further. Although researchers have begun to scratch the surface of this topic, a significant knowledge gap persists (Christoffel, 2007; Christoffel & Lepczyk, 2012). Further, because the majority of research investigating human-snake relationships has taken place in Africa, Asia, and Central and South America, this knowledge gap is particularly prominent in certain areas of North America such as the southeastern United States (Christoffel, 2007; Keener-Eck, 2009; Tomažič, 2011; Ceríaco, 2012; Torkar, 2015).

Although research specifically focused on perceptions of snakes is limited, comparable studies on factors impacting human responses to other potentially problematic wildlife species can offer some insights. Social-psychological research related to human-wildlife interactions indicates that behaviors toward certain wildlife species are influenced by a variety of factors that work in dynamic ways to elicit actions (Christoffel, 2007; Keener-Eck et al., 2019). Kollmuss and Agyeman (2002) proposed a model of pro-environmental behavior suggesting human actions result from a combination of both external and internal factors. External factors include various

socio-demographic and contextual variables, including social and cultural norms (Kollmuss & Agyeman, 2002; Jordan et al., 2020). Internal factors include past experience, knowledge, emotions, values and attitudes, and behavioral intentions (Kollmuss & Agyeman, 2002). In this paper, we examine how these variables influence tolerance for snakes.

Socio-demographic variables such as age, gender, and place of residence have been found to be important correlates of snake-related beliefs, attitudes, and behaviors (Vaske et al., 2011; Ceríaco, 2012; Liordos et al., 2018). Doctor et al. (2008) posited that fear of snakes increases up to the age of 20 and then subsequently declines over time. This argument was corroborated by Fredrikson et al. (1996), who found that among adults aged 18 and above, younger individuals demonstrated greater fear of certain animals when compared with older individuals. Contrary to these findings, Liordos et al. (2018) found that among a group of adults, younger respondents were more likely to be tolerant of snakes than older respondents. Several studies have shown that females tend to exhibit more negative attitudes, lower tolerance, and greater fear of snakes when compared with males (Prokop et al., 2009; Pinheiro et al., 2016; Polák et al., 2016; Liordos et al., 2018). Finally, rural residents are exposed to wildlife more frequently than those residing in more urban areas and are more likely to have negative attitudes toward certain wildlife species (Kleiven et al., 2004; Smith et al., 2014; Liordos et al., 2017). This was substantiated by Ceríaco (2012), who found that individuals living in rural communities were more likely to persecute snakes than those living in urban areas. Collectively, these patterns solidify normative responses to species that can permeate cultures and ultimately impact tolerance on larger scales (Brom et al., 2020). In addition to external socio-demographic variables, a variety of internal factors unique to individuals also play a role in influencing behavior.

Past experience is a critical factor that predicts behavioral intentions associated with wildlife (Rohan, 2000; Kollmuss & Agyeman, 2002; Christoffel, 2007; Manfredo, 2008; Kansky et al., 2016). According to Fazio and Zanna (1981), attitudes formed as a result of direct experiences are generally associated with high levels of certainty, enhanced stability over time, and strong resistance to opposition. For example, one study demonstrated that previous hands-on experience with snakes was associated with lower fear levels and more positive attitudes toward snake conservation (Torkar, 2015). Similarly, Pinheiro et al. (2016) found that past experience with snakes was associated with reduced negative attitudes and fear. Past experiences with snakes may also be associated with media exposure. Murray and Foote (1979) suggested that fear of snakes may be linked to negative stories about these animals displayed in movies, newspapers, and other media sources.

Knowledge is another factor that helps predict an individual's attitudes and behaviors with respect to wildlife (Bright & Manfredo, 1996; Kollmuss & Agyeman, 2002). Some studies have found positive associations between increased knowledge and more positive attitudes. Kellert (1985) found that as knowledge about wolves increased, attitudes toward these animals became more positive. In another study, researchers demonstrated that previous knowledge of rattlesnakes was associated with more positive attitudes toward these species (Christoffel, 2007). However, other studies have demonstrated that accurate knowledge of environmental issues does not necessarily translate to positive attitudes or behaviors (Ajzen et al., 2011; Heberlein, 2012). This stance was reinforced by Morgan (1992), who reported that increased knowledge of snakes failed to make children's attitudes toward snakes more positive. It is important to note that knowledge of wildlife-related concepts is multidimensional and can be assessed in different ways (White et al., 2018). In addition to knowledge of basic biological and ecological principles

(Kellert, 1994), species identification is often recognized as a necessary skill for developing a thorough understanding of key concepts related to wildlife sciences (Randler, 2008; White et al., 2018). Rapid species identification of snakes is particularly important so that humans can discern immediate threats (i.e., venomous species; Fančovičová et al., 2020).

Values represent other internal factors that guide actions related to wildlife (Kollmuss & Agyeman, 2002). Fulton et al. (1996) developed a framework known as the cognitive hierarchy, suggesting that fundamental values, or long-lasting beliefs or mental constructs that reflect our most basic desires and objectives, can be grouped into general wildlife value orientations (WVOs). WVOs represent basic belief patterns that provide context for values within the wildlife domain and can be used to predict more specific attitudes and subsequent behaviors (Fulton et al., 1996; Vaske & Manfredo, 2012; Jacobs et al., 2013). Recent work has established a WVO continuum that ranges from mutualism, representing those who believe wildlife deserve rights similar to those of humans, to domination, representing those who believe wildlife should be used primarily for human benefit (Fulton et al., 1996; Teel & Manfredo, 2010). With respect to reptiles, one study found that for well-liked species such as the eastern box turtle (*Terrapene carolina carolina*), both attitudes and behavioral intentions were strongly affected by participants' WVOs (Hartel et al., 2015). Another study showed people with stronger mutualistic WVOs were most likely to demonstrate positive attitudes toward rattlesnakes (Keener-Eck et al., 2020).

Many researchers have pointed out that the cognitive hierarchy fails to adequately address affective drivers of behaviors (Jacobs, 2012; Larson et al., 2016), despite the fact that human-wildlife interactions are thought to represent emotionally charged events in which affective responses such as fear and excitement may play a large role in dictating an individual's actions

(Hudenko, 2012). In recent years, there has been a push for more comprehensive evaluations of the emotional components of attitudes toward wildlife, as opposed to focusing primarily or solely on cognitive components (Morris et al., 2002; Manfredo, 2008; Hudenko, 2012; Jacobs, 2012). Larson et al. (2016) found that emotional dispositions were important in predicting wildlife management decisions. Another study linked valence, which represents the pleasant-unpleasant dimension of emotion, to WVOs (Abidin & Jacobs, 2019). A handful of studies have also addressed affective attitudes toward snakes by incorporating measures of fear (Constantine et al., 2001; Öhman et al., 2001; Rádlová et al., 2020). However, very few studies have addressed human emotions other than fear when it comes to perceptions of and subsequent behaviors toward snakes.

Behavioral intentions represent an individual's expectations regarding how they will behave in a given situation and are often seen as a way of measuring tolerance (Bruskotter & Fulton, 2012; Bruskotter & Wilson, 2013; St. John et al., 2018). The meaning of the term "tolerance" is debated (Bruskotter & Fulton, 2012; Treves et al., 2013), and may be viewed as an extension of an individual's attitudes or as a construct representative of their actual behaviors (Treves & Bruskotter, 2014; Bruskotter et al., 2015). In the context of human-wildlife interactions, tolerance can be defined on a spectrum from specific actions that *positively affect* wildlife such as habitat restoration (i.e., stewardship behaviors) to passive acceptance of wildlife (i.e., tolerance) to specific actions that *negatively affect* wildlife such as intentional killings (i.e., intolerance; Bruskotter & Fulton, 2012; Bruskotter & Wilson, 2014; Bruskotter et al., 2015; St. John et al., 2018). For the purposes of our study, we use tolerance as a proxy for behavioral intentions. Evaluating tolerance may be key in developing a better understanding of how people's perceptions lead to potentially harmful actions toward snakes (Brenner & Metcalf,

2020). However, the factors that influence wildlife tolerance are not well understood (Treves & Bruskotter, 2014; Bruskotter et al., 2015; Brenner & Metcalf, 2020). Studies addressing this topic have generally been directed at large predatory carnivores in the past (Naughton-Treves et al., 2003; Bruskotter & Fulton, 2012; Treves & Bruskotter, 2014; St. John et al., 2018), while very few have focused on tolerance toward snakes.

Our study addresses the need for a more comprehensive understanding of the variables that influence public perceptions of tolerance of snakes. We do this with a case study investigating how various behavioral antecedents influence tolerance for snakes among a group of undergraduate students at a large public university in the United States. Specifically, our study focused on the following objectives:

(1) Characterize students' past experience with snakes and demographic correlates;
(2) Determine students' knowledge of snakes, including both natural history and identification knowledge, and demographic correlates;
(3) Identify students' value orientations toward snakes and demographic correlates;
(4) Identify students' emotions toward snakes and demographic correlates;
(5) Measure students' tolerance (i.e., behavior intentions) for venomous and non-venomous snakes and identify demographic and social-psychological correlates of tolerance.

Methods

Participants

Over the course of two semesters (Fall 2019 and Spring 2020), we surveyed undergraduate students enrolled in four different courses at the university. Although courses were based in natural resource and life science programs, they were introductory-level courses and included students from a wide variety of backgrounds and majors. Our survey distribution strategy varied

based on instructor preferences. In some classes, we approached potential participants in the classroom, briefly introduced the research, and provided them with a link to the questionnaire at that time, which they could then access on their devices. In other classes, we recruited respondents and distributed a link to the questionnaire via an email through their professors or teaching assistants.

Survey Instrument & Data Analysis

Our survey instrument was designed in Qualtrics and focused on several types of variables that might influence students' perceptions of and actions toward snakes. Each of these variable groups is described in more detail below.

Demographic Variables

We asked participants to provide demographic information, including their gender (recoded as 1=male and 2=female), race/ethnicity (recoded as 1=White and 2=Black, indigenous, or People of Color), the year they were born (which we used to calculate age and then recoded as 1=ages 18 to 23 and 2=all other ages), the type of area (rural or urban) they grew up in based on population size (recoded as 1=less than 50,000 residents and 2=50,000 or more residents), and their major (recoded as 1=Agriculture/Life Sciences, Natural Resources, and Veterinary Medicine and 2=all other majors).

Past Experience

We presented respondents with a list of six possible snake-related experiences and asked them to select all of the experiences that applied to them. Responses were coded as 1 = has experienced or 0 = has not experienced. For analyses, we divided the list into negative (e.g., "I have been bitten by a snake", "my pet has been bitten by a snake before") and educational (e.g., "I have learned about snakes through educational programs") experiences. There was only one

item on the educational list. We calculated a sum for the total number of negative experiences, which could range from 0 to 5. For negative past experiences, we ran a linear regression with total number of negative experiences acting as the dependent variable and demographics acting as independent variables. For educational past experiences, we ran a logistic regression with number of educational experiences acting as the dependent variable and demographics acting as independent variables.

Because experience with snakes for many students might come through the media, we also asked participants to indicate the extent to which they believe snakes are portrayed negatively, positively, and accurately in the media using a 5-point Likert-type scale (1=always to 5=never). For analyses, we focused on their responses to negative portrayal in the media. We ran a linear regression using negative media portrayal score as the dependent variable and demographics as the independent variables.

Knowledge

We presented participants with three statements about the natural history of snakes (e.g., "all snakes are carnivorous", "snake skin is dry to the touch") and asked them to respond with either 'true', 'false', or 'uncertain'. We also provided participants with images of two different native snake species—a northern watersnake (*Nerodia sipedon*) and a pygmy rattlesnake (*Sistrurus miliarius*)—and asked them to indicate whether the depicted species was venomous or non-venomous. Participants could also select 'uncertain' as their answer. Responses for all six questions were coded as 0 = incorrect and 1 = correct. If participants selected 'uncertain', their response was considered incorrect. The number of correct natural history questions (0 through 3) and correct identification questions (0 through 2) were summed separately. We used principal components analysis (PCA) to examine the dimensionality of the six knowledge questions (Table

3.1). Cronbach's alpha for the full knowledge scale was 0.50. We also ran two linear regression models with total correct natural history or total correct identification questions acting as dependent variables and demographics acting as independent variables.

Table 3.1. Principal components analysis showing different dimensions of items measuring knowledge about snakes.

Knowledge Statement	**Mean**	**Factor Loading**	
		A	B
A. Natural History [a]	1.38		
All snakes are carnivorous	0.41	0.678	
Snake skin is dry to the touch	0.38	0.617	
All snakes are vertebrates	0.59	0.775	
Most snake species in NC are venomous [b]			
B. Identification [c]	0.58		
Pygmy rattlesnake	0.32		0.816
Northern watersnake	0.26		0.697

[a] Item response options: 1 (true), 2 (false), 3 (uncertain).

[b] One location-specific item demonstrated low factor loadings and was removed from further analyses: "Most snake species in NC are venomous"

[c] Item response options: 1 (venomous), 2 (not venomous), 3 (uncertain)

Wildlife Value Orientations

To assess WVOs toward snakes, we asked participants to indicate their level of agreement with four statements (adapted from Teel & Manfredo, 2010) using a five-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) for each. Two of the statements reflected the dominionistic WVO, while the other two reflected the mutualistic WVO. We separated the two pairs of statements for our data analyses so that we had a dominionistic variable and mutualistic variable. We recoded the scales for both the mutualistic and dominionistic WVOs so that -2 represented strong disagreement and +2 represented strong agreement. We used PCA to test scale dimensionality with regards to the four WVO items (Table 3.2). We also used Cronbach's alpha to measure internal validity for each of the two-item scales. For the mutualism scale, we got $\alpha = 0.49$ and for the dominionistic scale, we got $\alpha = 0.61$. We ran two linear

regression models with average dominionistic score and average mutualistic score acting as the dependent variables and demographics acting as the independent variables.

Table 3.2. Principal components analysis showing different dimensions of items measuring wildlife value orientations toward snakes.

WVO Item	Mean	SD	Factor Loading	
			A	B
A. Mutualistic value orientation [a]	0.137	0.827		
Animals, including snakes should have rights similar to the rights of humans	-0.101	1.1016	0.686	
I take great comfort in the relationships I have with animals, including snakes	0.376	1.019	0.877	
B. Dominionistic value orientation [a]	0.690	0.805		
The needs of humans should take priority over snake protection	0.423	1.008		0.857
It is acceptable for people to kill snakes if they pose a threat to them or their animals	0.957	0.885		0.788

[a] Item response options: scale from 1 (strongly disagree) to 5 (strongly agree), recoded as -2 (strongly disagree) to +2 (strongly agree)

Affective Responses

We used the Self-Assessment Manikin (SAM; Bradley & Lang, 1994) to assess affective responses toward snakes (Morris et al., 2002). We provided respondents with two different images of snakes, one of which featured a venomous timber rattlesnake (*Crotalus horridus*) poised in striking position and the other which showed a smaller, non-venomous rough green snake (*Opheodrys aestivus*). We then asked respondents to indicate, using SAM, how each of these images made them feel on spectrums from unpleasant to pleasant, relaxed to stimulated, and controlled to controlling. This study focused on measures of pleasantness and intensity, both of which were measured on five-point scales ranging from 1 (unpleasant or relaxed) to 5 (pleasant or stimulated). We ran separate linear regressions for pleasantness and intensity for both the venomous snake photo and non-venomous snake photo, with demographics acting as the independent variables.

Tolerance

To measure tolerance, or behavioral intent, we asked participants to indicate the behavior (1=kill it or get someone else to, 2=relocate it or get someone else to, 3=leave it alone) in which they would most likely engage if they encountered a snake right outside of their residence. The question featured three different scenarios, based on if they were: (a) confident the snake was non-venomous, (b) confident the snake was venomous, and (c) uncertain whether the snake was venomous or non-venomous (though this last option was only included on the 2020 survey instrument).

Table 3.3. Variables in multinomial logistic regression model predicting tolerance of NCSU undergraduate students (N = 743)

Variable	Definition	Mean	SD
PositiveExperience	Total number of educational past experiences (Scale: 0 to 1)	0.82	0.39
NegativeExperience	Total number of negative past experiences (Scale: 0 to 5)	1.99	1.07
NegativeMedia	Perceived negative portrayal of snakes in media (Scale: 1 = always to 5 = never)	2.06	0.58
NaturalHistoryCorrect	Total number of correct natural history questions (Scale: 0 to 3)	1.38	1.03
IdentificationCorrect	Total number of correct identification questions (Scale: 0 to 2)	0.58	0.69
DominionisticValues	Mean dominionistic score (Scale: -2 = strongly agree to +2 = strongly disagree)	0.69	0.81
MutualisticValues	Mean mutualistic score (Scale: -2 = strongly disagree to +2 = strongly agree)	0.14	0.83
VenomousValence	Pleasantness score toward photo of timber rattlesnake (Scale: 1 = unpleasant to 5 = pleasant)	2.26	1.07
VenomousIntensity	Intensity score toward photo of timber rattlesnake (Scale: 1 = relaxed to 5 = stimulated)	3.30	1.13
NonVenomousValence	Pleasantness score toward photo of rough green snake (Scale: 1 = unpleasant to 5 = pleasant)	3.61	1.21
NonVenomousIntensity	Intensity score toward photo of rough green snake (Scale: 1 = relaxed to 5 = stimulated)	2.28	1.12
Gender	Dummy variable: 0 if male, 1 if female	0.61	0.49
Race	Dummy variable: 0 if White, 1 if non-white	0.27	0.45
Age	Dummy variable: 0 if 18-23 years, 1 if other	0.05	0.22
Residence	Dummy variable: 0 if under 50,000, 1 if over 50,000	0.51	0.50
Major	Dummy variable: 0 if Agricultural/Life Sciences, Natural Resources, or Vet Medicine, 1 if other	0.78	0.42

Using R, we ran three multinomial logistic regression models for each of the three tolerance scenarios (i.e., non-venomous, venomous, and uncertain). ‘Leave alone’ was used as

the reference category that was compared to 'kill' and 'relocate' behavioral intent items in all three models. For each model, we incorporated the following as independent variables: number of educational past experiences, number of negative past experiences, interpretation of negative media portrayal, total correct natural history responses, total correct identification responses, average mutualistic score, average dominionistic score, measures of pleasantness and intensity for the two snake photos, as well as demographic variables related to age, gender, race/ethnicity, residence type, and major (Table 3.3).

Results

Sample Characteristics

We received 743 completed surveys, including 340 from the 2019 semester and 403 from the 2020 semester. Ages ranged from 17 to 49 years (M = 20, SD = 2.35). 95.0% of respondents were 19 to 23 years old, which encompass traditional ages for undergraduate students. The majority of respondents were female (60.5%) and White (72.6%), reflecting the demographic ratios of the institution. Only 22.3% of our respondents were majoring in Agriculture/Life Sciences, Natural Resources, or Vet Medicine, while the remaining 77.7% had other majors. Approximately half (48.9%) of our respondents grew up in areas with less than 50,000 residents, while the other half (50.7%) grew up in areas with 50,000 or more residents.

Past Experience

Of our respondents, 81.8% indicated they had an educational past experience with snakes (i.e., learned about snakes through educational programs). However, 92.9% of students reported at least one negative experience with snakes and 64.9% of respondents reported two or more negative snake experiences. The most commonly cited negative past experience was hearing about venomous snake bite accounts through the media. Race/ethnicity (B = -0.323, $p < 0.001$)

and type of residence (B = -0.185, $p = 0.022$) were significant predictors of the total number of negative past experiences. On average, White students and those residing in more rural areas reported more negative experiences with snakes. The only demographic correlate of educational snake experiences was race/ethnicity (B = -0.531, $p = 0.012$), with more White students indicating they had this experience.

84.1% ($M = 2.057$, SD = 0.58) of respondents indicated they felt snakes were portrayed negatively in the media either always or often. This suggested that on average, respondents felt snakes were portrayed negatively in the media often. Gender (B = -0.158, $p < 0.001$) and major (B = 0.103, $p = 0.049$) were both significant predictors of negative media portrayal score. Female respondents and those majoring in Agriculture/Life Sciences, Natural Resources, or Veterinary Medicine expressed that snakes are portrayed negatively in the media more frequently when compared with males and those majoring in other fields.

Knowledge

Only 16.6% of respondents answered all three natural history questions used in analyses correctly, while 11.8% answered zero correctly (M = 1.38, SD = 1.03). Linear regression showed that only major (B = -0.383, $p < 0.001$) was a significant predictor of total number of correct natural history questions. The mean number of correct natural history questions for students majoring in Agriculture/Life Sciences, Natural Resources, or Veterinary Medicine was 2.36 (SD = 1.14), while the average for students with other majors was 1.93 (SD = 1.21). Only 11.8% of respondents answered both identification questions correctly, while 53.8% answered neither correctly (M = 0.58, SD = 0.69). Only gender (B = -0.120, $p = 0.024$) had a significant effect on number of correctly answered identification questions, with males averaging 0.651 correct questions (SD = 0.714) and females averaging 0.533 (SD = 0.678) correct questions.

Value Orientations

The average mutualistic score across all respondents was 0.137 (*SD* = 0.83), while the average dominionistic score across all respondents was -0.690 (*SD* = 0.81). Both mutualistic (B = 0.146, $p = 0.021$) and dominionistic (B = 0.258, $p < 0.001$) WVO scores were significantly affected by gender, with males expressing higher dominionistic WVOs and lower mutualistic WVOs when compared with females. Average dominionistic scores were also significantly affected by race/ethnicity, with White respondents expressing stronger dominionistic scores (B = -0.137, $p = 0.042$).

Affective Responses

Average pleasantness and intensity scores for the venomous timber rattlesnake photo across all respondents were 2.26 (SD = 1.07) and 3.30 (SD = 1.13), respectively. Pleasantness for the venomous species was significantly affected by age (B = 0.363, $p = 0.049$), gender (B = -0.246, $p = 0.003$), and major (B = -0.269, $p = 0.006$). Generally, respondents outside of the 18 to 23 age range, males, and those majoring in Agriculture/Life Sciences, Natural Resources, or Veterinary Medicine indicated that they felt more pleasant about this photo. Intensity for the venomous species was significantly affected by both race/ethnicity (B = -0.253, $p = 0.009$) and gender (B = 0.197, $p = 0.023$). Generally, White students and females felt more stimulated by the photo of the timber rattlesnake.

For the photo of the non-venomous rough green snake, the average pleasantness score was 3.61 (SD = 1.21), while the average intensity score was 2.28 (SD = 1.12) across all respondents. There were no significant predictors of pleasantness for the rough green snake photo. In terms of intensity, gender was the only significant predictor (B = 0.209, $p = 0.014$), with males expressing a greater degree of relaxation versus stimulation when compared with females.

Tolerance

For encounters with non-venomous snakes, the majority of respondents said they would leave it alone (Figure 3.1). For encounters with venomous snakes, the majority of respondents said they would relocate the snake (or ask someone else to move it), followed closely by killing the snake (or asking someone else to kill it). For snakes that respondents were uncertain about, the majority of respondents indicated they would either kill or relocate the snake. Thus, killing and relocating snakes were the most common responses when snakes were presumed to be venomous, or identification of the snake was uncertain.

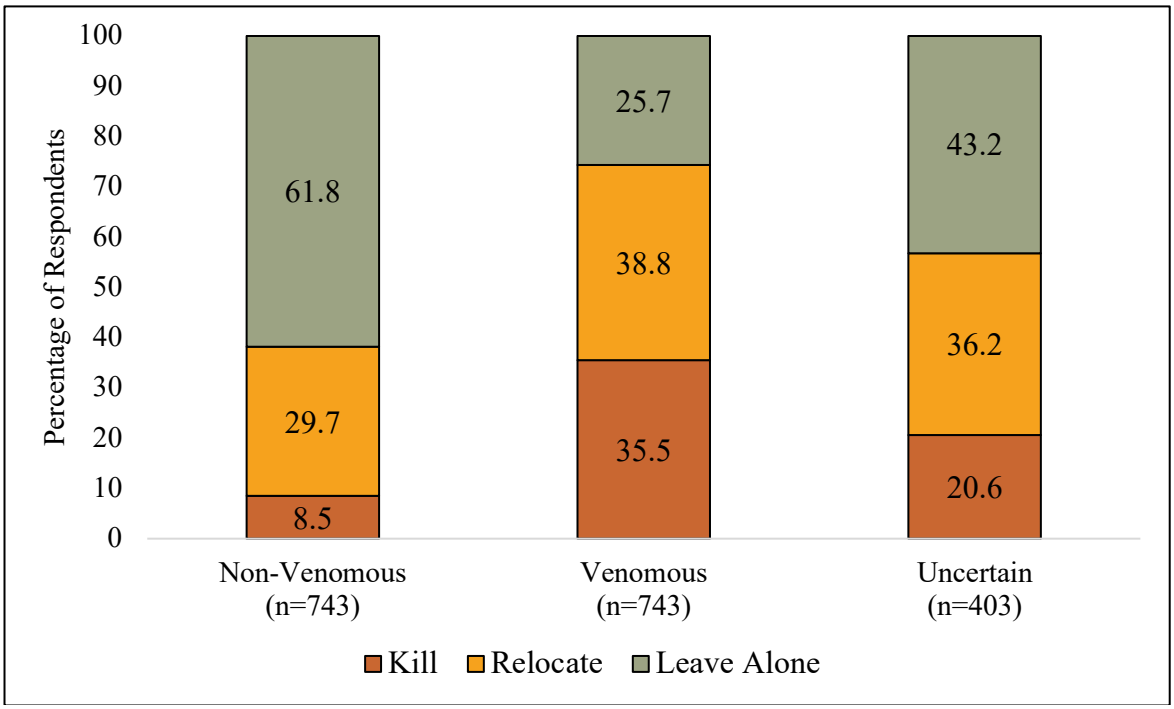

Figure 3.1. Frequency of reported behavioral intentions (or tolerance) of snakes among college students in North Carolina based on three hypothetical scenarios: encountering a non-venomous snake, a venomous snake, or a snake that is uncertain.

For the model in which the respondent was certain the snake was non-venomous (Nagelkerke $R^2 = 0.239$), respondents who expressed lower mutualism values (OR = 0.564, $p = 0.010$), higher dominionistic values (OR = 4.593, $p < 0.001$), less pleasant responses toward the non-venomous snake photo (OR = 0.533, $p < 0.001$), and lower levels of natural history

knowledge (OR = 0.743, p = 0.090) were more likely to kill a snake relative to the reference category of leaving it alone (Table 3.4). The only significant predictor of relocating the snake relative to leaving it alone was total number of negative past experiences with snakes (OR = 1.181, $p = 0.050$).

Table 3.4. Parameter estimation from the multinomial logistic regression model predicting tolerance of non-venomous snakes among undergraduate students in North Carolina (n = 743)

Variable	Kill			Relocate		
	β (SE)	Wald	OR	β (SE)	Wald	OR
Constant	-2.042 (1.636)	1.558		-1.343 (0.822)	2.669	
Gender (female)	0.075 (0.347)	0.047	1.078	-0.028 (0.181)	0.025	0.972
Race (BIPOC)	0.205 (0.372)	0.304	1.227	0.080 (0.196)	0.166	1.083
Age (non-traditional)	-0.931 (1.130)	0.678	0.394	-0.653 (0.447)	2.132	0.521
Residence (urban)	-0.324 (0.337)	0.925	0.723	0.232 (0.178)	1.705	1.261
Major (non-ag/NR)	-0.436 (0.414)	1.107	0.647	0.208 (0.222)	0.879	1.234
PositiveExperience	-0.585 (0.379)	2.388	0.557	-0.361 (0.236)	2.344	0.697
NegativeExperience	0.125 (0.159)	0.613	1.133	0.166 (0.085)	3.849	1.181**
NegativeMedia	-0.381 (0.266)	2.050	0.683	-0.024 (0.153)	0.025	0.976
NaturalHistoryCorrect	-0.297 (0.175)	2.872	0.743*	-0.043 (0.088)	0.245	0.958
IdentificationCorrect	0.305 (0.243)	1.578	1.3157	-0.154 (0.128)	1.435	0.857
DominionisticValues	1.525 (0.295)	26.665	4.593***	0.022 (0.120)	0.034	1.022
MutualisticValues	-0.573 (0.223)	6.579	0.564***	0.021 (0.123)	0.030	1.022
NonVenomousValence	-0.629 (0.183)	11.833	0.533***	-0.003 (0.102)	0.001	0.997
NonVenomousIntensity	0.138 (0.179)	0.593	1.148	0.151 (0.102)	2.183	1.163

Note: The "leave snake alone" category (61.8%, n = 459) was considered as the reference for comparisons with the other tolerance categories of "kill" (8.5%, n = 63) and "relocate" (29.7%, n = 221).
*, **, and *** denote statistical significance of alpha at 0.10, 0.05, and 0.001, respectively.
Model Fit Statistics: $\chi^2(1386) = 1609.4$, $p < 0.001$, Nagelkerke pseudo-$R^2 = 0.239$.

For the scenario in which the respondent was certain the snake was venomous (Nagelkerke $R^2 = 0.312$), respondents who expressed weaker mutualistic scores (OR = 0.566, $p < 0.001$), stronger dominionistic scores (OR = 2.495, $p < 0.001$), and pleasant responses toward the

venomous photo (OR = 0.614, $p < 0.001$) demonstrated increased likelihood that they would kill the venomous snake relative to the reference category of leaving it alone (Table 3.5). Additionally, females were more likely to kill venomous snakes when compared with males (OR = 1.078, $p = 0.040$). There were no significant predictors of relocating the snake relative to the reference category.

Table 3.5. Parameter estimation from the multinomial logistic regression model predicting tolerance of venomous snakes among undergraduate students in North Carolina (n = 743)

Variable	Kill			Relocate		
	β (SE)	Wald	OR	β (SE)	Wald	OR
Constant	0.009	0.179		0.623	2.717	
	(0.862)			(0.753)		
Gender (female)	0.471	4.228	1.600**	0.199	0.928	1.220
	(0.229)			(0.206)		
Race (BIPOC)	-0.166	0.441	0.847	-0.172	0.600	0.842
	(0.250)			(0.222)		
Age (non-traditional)	-0.411	0.519	0.663	0.196	0.227	1.217
	(0.570)			(0.413)		
Residence (urban)	0.151	0.459	1.163	0.320	2.508	1.377
	(0.222)			(0.202)		
Major (non-ag/NR)	0.359	1.740	1.433	0.173	0.537	1.189
	(0.272)			(0.237)		
PositiveExperience	-0.437	2.143	0.646	-0.195	0.469	0.823
	(0.299)			(0.285)		
NegativeExperience	0.159	2.179	1.172	-0.134	1.930	0.875
	(0.108)			(0.096)		
NegativeMedia	-0.031	0.027	0.969	-0.059	0.109	0.943
	(0.192)			(0.178)		
NaturalHistoryCorrect	0.064	0.339	1.067	0.070	0.489	1.072
	(0.111)			(0.100)		
IdentificationCorrect	0.077	0.230	1.080	-0.003	0.001	0.997
	(0.160)			(0.143)		
DominionisticValues	0.914	28.816	2.495***	-0.262	3.572	0.769*
	(0.170)			(0.139)		
MutualisticValues	-0.568	13.194	0.566***	0.198	1.866	1.218
	(0.156)			(0.145)		
VenomousValence	-0.488	12.957	0.614***	-0.135	1.428	0.874
	(0.136)			(0.113)		
VenomousIntensity	0.001	0.000	1.001	0.077	0.560	1.080
	(0.118)			(0.103)		

Note: The "leave snake alone" category (25.7%, n = 191) was considered as the reference for comparisons with the other tolerance categories of "kill" (35.5%, n = 264) and "relocate" (38.8%, n = 288).
*, **, and *** denote statistical significance of alpha at 0.10, 0.05, and 0.001, respectively.
Model Fit Statistics: $\chi^2(1392) = 1414.7$, p = 0.33, Nagelkerke pseudo-$R^2 = 0.312$.

Finally, for the scenario in which the respondent was uncertain whether the snake was venomous or non-venomous (Nagelkerke $R^2 = 0.274$), respondents who expressed stronger

dominionistic (OR = 2.113, $p = 0.002$) and weaker mutualistic (OR = 0.513, $p = 0.001$) scores were more likely to kill a snake relative to the reference category of leaving the snake alone. Additionally, for this scenario, respondents who had grown up in more urban areas were more likely to relocate the snake relative to the reference category when compared with more rural residents (OR = 0.661, $p = 0.046$, Table 3.6).

Table 3.6. Parameter estimation from the multinomial logistic regression model predicting tolerance of snakes an individual was uncertain whether it was venomous or non-venomous among undergraduate students in North Carolina (n = 403)

Variable	Kill			Relocate		
	β (SE)	Wald	OR	β (SE)	Wald	OR
Constant	-0.329 (1.578)	0.044		0.688 (1.218)	0.319	
Gender (female)	0.464 (0.332)	1.951	1.590	0.207 (0.257)	0.652	1.230
Race (BIPOC)	-0.040 (0.363)	0.012	0.962	-0.273 (0.291)	0.878	0.761
Age (non-traditional)	-0.375 (0.879)	0.182	0.687	-1.098 (0.682)	2.590	0.333
Residence (urban)	-0.090 (0.317)	0.080	0.914	0.508 (0.255)	3.987	1.661**
Major (non-ag/NR)	0.810 (0.580)	1.948	2.247	0.132 (0.421)	0.099	1.142
PositiveExperience	-0.779 (0.432)	3.248	0.459*	-0.677 (0.356)	3.612	0.508*
NegativeExperience	-0.031 (0.153)	0.040	0.970	-0.120 (0.123)	0.938	0.887
NegativeMedia	0.077 (0.237)	0.106	1.080	-0.266 (0.211)	1.593	0.766
NaturalHistoryCorrect	0.202 (0.156)	1.675	1.224	-0.073 (0.124)	0.341	0.930
IdentificationCorrect	0.372 (0.223)	2.779	1.451*	0.128 (0.179)	0.507	1.136
DominionisticValues	0.748 (0.247)	9.146	2.113***	-0.147 (0.178)	0.679	0.864
MutualisticValues	-0.667 (0.207)	10.371	0.513***	0.001 (0.172)	0.000	1.001
VenomousValence	-0.265 (0.219)	1.465	0.767	-0.207 (0.160)	1.668	0.813
VenomousIntensity	0.181 (0.188)	0.925	1.198	0.114 (0.148)	0.595	1.121
NonVenomousValence	-0.332 (0.188)	3.098	0.718*	0.075 (0.154)	0.239	1.078
NonVenomousIntensity	-0.150 (0.197)	0.581	0.861	-0.247 (0.162)	2.327	0.781

Note: The "leave snake alone" category (43.2%, n = 174) was considered as the reference for comparisons with the other tolerance categories of "kill" (20.6%, n = 83) and "relocate" (36.2%, n = 146).
*, **, and *** denote statistical significance of alpha at 0.10, 0.05, and 0.001, respectively.
Model Fit Statistics: $\chi^2(726) = 725.6$, p = 0.50, Nagelkerke pseudo-$R^2 = 0.274$.

Discussion

Our findings underscore the challenge of promoting snake conservation and stewardship behaviors in several ways. First, the high incidence of negative past experiences with snakes presents the potential for previously formed negative perceptions of these animals that may have an impact on WVOs and subsequent behavioral intentions. Deruiter (2002) suggested direct experiences with wildlife, including extractive, appreciative, and fear/negative experiences, contribute to the formation of WVOs. The finding that White respondents were more likely to have had more negative experiences with snakes as well as more educational snake-related experiences in the past could be explained by differences in the way people from different ethnic backgrounds are exposed to nature and wildlife (Larson et al., 2010). Additionally, the finding that respondents who grew up in more rural areas had more negative experiences with snakes than urban respondents align with a study by Kretser et al. (2009) who found negative wildlife experiences were substantially more common among rural residents. The fact that the majority of respondents indicated they felt snakes were portrayed negatively in the media often or always, combined with the fact that the most commonly cited negative past experience with snakes was hearing about venomous snake bite accounts in the media, highlight the capacity for media to influence wildlife-related attitudes, particularly with potentially dangerous species.

Past research on wildlife-related knowledge has produced results similar to ours. For instance, some studies have demonstrated low knowledge about most wildlife in the U.S. (Kellert & Berry, 1980; Zinn & Andelt, 1999). More recently, Christoffel (2007) found that respondents had little knowledge about both non-venomous and venomous snakes. Another study in Australia found that common local snake species were frequently misidentified (Wolfe et al., 2020). Our finding that students with majors related to Agriculture/Life Sciences, Natural Resources, or

Veterinary Medicine tended to answer natural history questions correctly more often than those majoring in other fields (M = 1.69, SD = 0.95) was unsurprising given the nature of these majors. Our finding that males exhibited a greater capacity to correctly identify venomous versus non-venomous snakes could potentially be explained by a "more cognitive and logically abstract perception of animals" (Kellert & Berry, 1987) among males when compared with females (Gilligan, 1982).

Our findings suggest snakes may represent an outlier when it comes to the general shift in wildlife value orientations from more dominionistic to more mutualistic beliefs among Americans (Manfredo & Zinn, 1996; Manfredo et al., 2020a). Some have proposed that this shift should be occurring more quickly among younger generations (Manfredo et al., 2020b). Therefore, if present, this effect should have been relatively pronounced in our sample since we targeted an undergraduate student population made up primarily of young adults. However, stronger agreeance with both dominionistic statements when compared with mutualistic statements suggests our respondents generally believe humans are superior to snakes and that a shift in values associated with snakes may be lagging. Our finding that, on average, male respondents demonstrated higher dominionistic scores and lower mutualism scores than females echo previous studies exploring the effects of gender on WVOs (Kellert & Berry, 1987; Zinn & Pierce, 2002; Hermann et al., 2013).

Our finding that a photo of a rattlesnake elicited greater arousal and lower valence than a photo of a rough green snake may be partially explained by risk perceptions of certain species and subsequent fear levels. Landová et al. (2020) found that psychophysiological responses to images of fear-inducing venomous snake species were stronger than responses elicited by images of non-venomous snakes. The fact that fear is often characterized by both high arousal and low

pleasantness (Russell et al., 1989) and potentially dangerous venomous species often trigger greater fear levels than non-venomous species, it makes sense that our respondents experienced greater unpleasantness and stimulation toward the rattlesnake photo when compared with the rough green snake photo. Our finding that females reacted to both photos with greater unpleasantness as well as greater stimulation, combined with the fact that females exhibited significantly stronger mutualistic and weaker dominionistic scores, suggest that despite having WVOs more aligned with supporting snake conservation, emotional reactions may interfere with the development of more positive attitudes and lead to behaviors that negatively impact snakes.

Our analyses of demographic and social-psychological correlates revealed different ways to predict and influence students' reactions to snakes. Ultimately, our findings highlighted important differences in tolerance when it comes to venomous, non-venomous, and unidentified snake species. The substantial role of value orientations in predicting tolerance toward snakes in all three scenarios echo previous studies in which WVOs were found to have significant effects on behavioral intentions toward wildlife (Stephenson, 2013; Hartel et al., 2015). Messaging tactics specifically geared toward groups with certain value orientations may be important for influencing tolerance in our region. This is supported by a study demonstrating that information about WVOs may be used to guide messaging and communication from wildlife managers to the public (Miller et al., 2018). Vaske et al. (2011) also found that WVO estimates can be used by managers to help predict public support for various wildlife management practices, which may in turn help guide their planning processes.

Additionally, the significance of valence and intensity in predicting whether an individual would kill a venomous or non-venomous snake suggests that emotion plays an important role in determining tolerance. Emotions that arise during experiences with wildlife are thought to play a

role in relevant wildlife attitudes and subsequent behaviors later on (Hudenko, 2012; Larson et al., 2016). For some species, fostering positive experiences may have the capacity to combat past negative experiences (Teixeira et al., 2020). Thus, when given the opportunity, it may be important for managers to highlight positive snake-related experiences in order to foster the development of positive emotions toward snakes. It is important to note that despite the weaker dominionistic and stronger mutualistic scores of females in the venomous scenario, females were significantly more likely to kill venomous snakes. Since females also exhibited significantly lower valence scores when it came to venomous species, this finding highlights the power of affective responses in determining an individual's actions toward certain wildlife. In other words, in certain scenarios, emotions may override value orientations and lead to certain actions.

Although demographics were less important in directly predicting tolerance, we suggest that in some cases, demographic variables may still influence behavioral intentions indirectly by acting as moderators. According to Baron and Kenny (1986), a moderator is "a variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable". Due to our finding that gender was a significant predictor of both mutualistic and dominionistic WVOs, which were in turn significant predictors of tolerance, we argue that gender may have an indirect effect on whether an individual will kill a snake or not. In other words, because males had significantly higher dominionistic and lower mutualistic scores, they may ultimately be more likely to kill snakes in certain scenarios.

The fact that knowledge variables had no significant effect on tolerance for snakes support past theories that increasing factual information about a given species is not enough to significantly influence attitudes or behavioral intentions (Heberlein, 2012; Skupien et al., 2016). As such, focusing solely or even primarily on educational outreach as a way of influencing

tolerance of snakes may not be particularly effective. However, the fact that on average, respondents were over two times as likely to kill a snake they were uncertain about than they were to kill a snake they were certain was non-venomous, combined with the high incidence of inability to correctly identify venomous versus non-venomous species, highlights a potentially prominent conservation problem for these animals. Ultimately, inability to differentiate between venomous and non-venomous snake species could potentially result in less-informed decision-making that contributes to active persecution of snakes. That being said, managers may want to avoid focusing solely or primarily on increasing factual knowledge if the ultimate goal is to achieve attitudinal and/or behavioral change. Instead, managers and educators may want to incorporate strategies that target multiple behavioral antecedents at once. For instance, providing people with positive direct experiences, combined with factual information, has the potential to be effective. Educational outreach efforts may operate as vehicles for replacing negative snake-related experiences with more positive ones.

Limitations

Several limitations should be considered when interpreting the results of this study. First, our sample was very specific, including only undergraduate students from one university in one region. Although our goal was to target this specific population, caution should be taken when extrapolating our results considering the fact that perceptions of snakes may vary regionally (Keener-Eck, 2009). Nevertheless, the lack of previous studies on this topic in the southeastern U.S. make this study novel and important. Additionally, our methodology invites potential biases that should be considered. For instance, self-report questionnaires are often subject to social-desirability response bias in which respondents answer questions in a way they think the researcher or their peers would want them to (Whitehouse-Tedd et al., 2020). In the future,

combining self-report questionnaires with more objective measures, such as implicit association tests or physiological tracking may be beneficial.

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APPENDICES

Appendix A. Images of snakes and songbirds used as stimuli in IAT in Chapter 2 study.










Appendix B. Survey instrument used in Chapter 3 study.

What do you think about snakes?

This brief questionnaire is designed to help us understand what undergraduate students at NC State think about snakes and how they might interact with them. Your participation in this study is voluntary and all responses will be confidential.

Please read the following statement and indicate whether you consent to participate or not:

By electronically signing this consent form, I am affirming that I have read and understand the above information. I have chosen to participate in this study with the understanding that I may stop participating at any time without penalty or loss of benefits to which I am otherwise entitled. I am aware that I may revoke my consent at any time.

☐ Yes, I agree to participate in this study. Please take me to the survey.
☐ No, I do not want to participate in this study.

Section 1: Past Experience

Mark each of the following statements that apply to you:

☐ I have been bitten by a snake
☐ I have learned about snakes through educational programs (classes, museum or zoo tours, etc.)
☐ I have heard accounts of dangerous snakes or snakebites from friends and family
☐ I have learned about venomous snakebite accounts through the media (e.g., film, print, TV, social media)
☐ I know someone who has been bitten by a snake before
☐ My pet has been bitten by a snake before
☐ None of these apply for me

In your opinion, how frequently are snakes portrayed negatively in the media (e.g., film, print, TV, social media)?

☐ Always
☐ Often
☐ Sometimes
☐ Seldom
☐ Never

In your opinion, how frequently are snakes portrayed accurately in the media (e.g., film, print, TV, social media)?

☐ Always
☐ Often
☐ Sometimes
☐ Seldom
☐ Never

Section 2: Natural History Knowledge

For the following items, indicate whether you believe the provided statement is true or false. If you are not sure, select *uncertain*.

All snakes are carnivorous.
☐ True
☐ False
☐ Uncertain

Snake skin is dry to the touch.
☐ True
☐ False
☐ Uncertain

Most snake species in North Carolina are venomous.
☐ True
☐ False
☐ Uncertain

All snakes are vertebrates.
☐ True
☐ False
☐ Uncertain

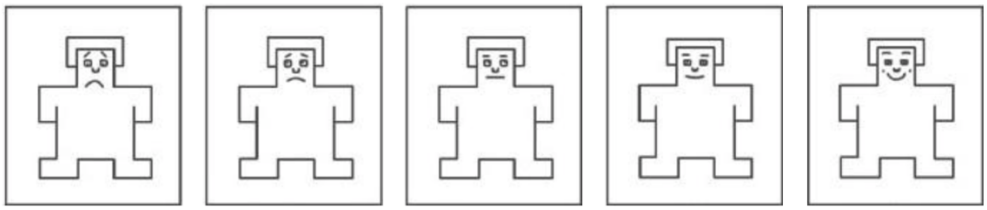
Section 3: Value Orientations

Mark the extent to which you agree with the following statements.

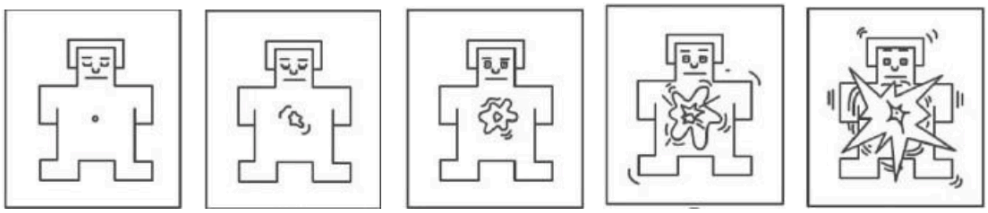
	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The needs of humans should take priority over snake protection.	○	○	○	○	○
It is acceptable for people to kill snakes if they pose a threat to them or their animals.	○	○	○	○	○
Animals, including snakes, should have rights similar to the rights of humans.	○	○	○	○	○
I take great comfort in the relationships I have with animals, including snakes.	○	○	○	○	○

Section 4: Emotions

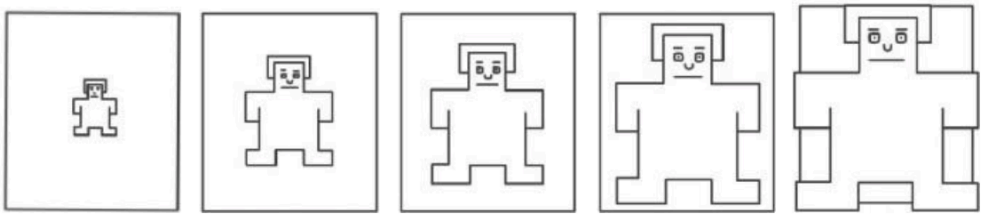
How does the snake in this photo make you feel on a spectrum from *unpleasant* to *pleasant*?



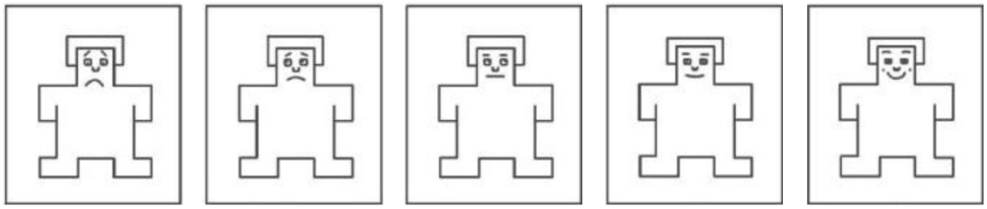
How does the snake in this photo make you feel on a spectrum from *relaxed* to *stimulated*?



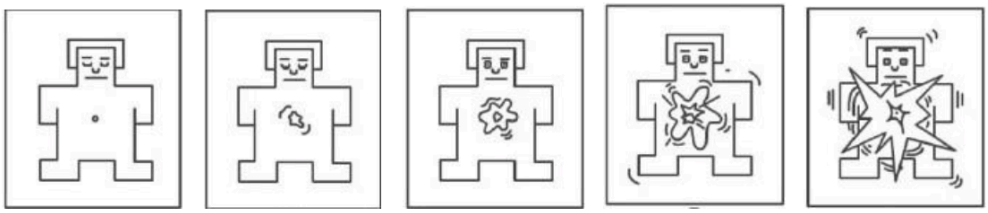
How does the snake in this photo make you feel on a spectrum from *controlled* to *controlling*?



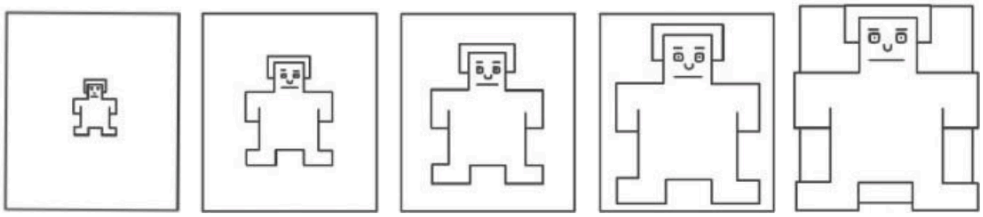
How does the snake in this photo make you feel on a spectrum from unpleasant to pleasant?



How does the snake in this photo make you feel on a spectrum from relaxed to stimulated?



How does the snake in this photo make you feel on a spectrum from *controlled* to *controlling*?



Section 5: Identification Knowledge

The snake pictured above is:
☐ Venomous
☐ Not venomous
☐ I'm not sure

The snake pictured above is:
☐ Venomous
☐ Not venomous
☐ I'm not sure

Section 6: Tolerance

For the following scenario, indicate which action you would be most likely to take:

*You are right outside of your residence, and there is a snake that you are confident is **not venomous**.*

☐ Kill it or get someone else to
☐ Relocate it or get someone else to
☐ Leave it alone

For the following scenario, indicate which action you would be most likely to take:

*You are right outside of your residence, and there is a snake that you are confident is **venomous**.*

☐ Kill it or get someone else to
☐ Relocate it or get someone else to
☐ Leave it alone

For the following scenario, indicate which action you would be most likely to take:

*You are right outside of your residence and you see a snake, but you are **NOT SURE if it is venomous or non-venomous**.*

☐ Kill it or get someone else to
☐ Relocate it or get someone else to
☐ Leave it alone

Section 7: Demographics

Which of the following best describes the area where you grew up?

☐ Large city or urban area with more than 250,000 people
☐ Medium city with 50,000-250,000 people
☐ Small city with 10,000-50,000 people
☐ Small or rural town with less than 10,000 people
☐ Other (describe) _____

Which of the following colleges at NCSU do you study in? Or which would you be most likely to study in?

☐ College of Agriculture and Life Sciences
☐ College of Design
☐ College of Education
☐ College of Engineering
☐ College of Humanities and Social Sciences
☐ College of Natural Resources
☐ College of Sciences
☐ College of Vet Medicine
☐ Poole College of Management
☐ Wilson College of Textiles

What year were you born?

_____

What gender do you identify as?

☐ Female
☐ Non-binary
☐ Male
☐ Not listed (specify) _____

Which of the following best describes your racial/ethnic background? Select all that apply.

☐ Asian
☐ Black or African American
☐ Hispanic/Latino
☐ Middle Eastern or North African
☐ Native American or Native Alaskan
☐ Native Hawaiian or Pacific Islander
☐ White
☐ Other (specify) _____