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The Bee's Knees or Spines of a Spider: What Makes an 'Insect' Interesting?

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THE BEE'S KNEES OR SPINES OF A SPIDER: WHAT MAKES AN "INSECT" INTERESTING?

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ABSTRACT

[1]Insects and their kin (bugs) are among the most detested and despised creatures on earth. Irrational fears of these mostly harmless organisms often restrict and prevent opportunities for outdoor recreation and leisure. Alternatively, Shipley and Bixler (2016) theorize that direct and positive experiences with bugs during middle childhood may result in fascination with insects leading to comfort in wildland settings. The objective of this research was to examine and identify the novel and unfamiliar bug types that people are more likely to find interesting and visually attend to when spontaneously presented with their images. This research examined these questions through four integrated exploratory studies. The first study (n = 216) found that a majority of adults are unfamiliar with a majority of bugs, despite the abundance of many common but 'unfamiliar' bugs. The second (n = 15) and third (n = 308) study examined participant's first impressions of unfamiliar bugs. The second study consisted of in-depth interviews, while the third study had participants report their perceptions of bugs across multiple emotional dimensions. Together, both studies suggest there are many unfamiliar bugs that are perceptually novel and perceived as interesting when encountered. The fourth study (n = 48) collected metrics of visual attention using eye-tracking by measuring visual fixations while participants viewed different bugs identified through previous studies as either being interesting or disinteresting. The findings of the fourth study suggest that

[1] For the purpose of this research, insect and bug will refer to any land invertebrate excluding crustaceans. This includes, but is not limited to; insects, spiders, scorpions, centipedes, millipedes, snails, slugs, ticks, and pill bugs. This classification is similar to modern folk taxonomic classification systems of what constitutes a bug.

interesting bugs can capture more visual attention than uninteresting bugs. Results from all four studies provide a heuristic for interpretive naturalists, magazine editors, marketers, public relation advisors, filmmakers, and any other visual communication professional that can be used in the choice of images of unfamiliar images of insects and other small invertebrates to evoke situational interest and motivate subsequent behavior.

Keywords: visual attention, eye tracking, bugs, insects, interpretive naturalists, visual communications, interestingness, novelty

DEDICATION

I would like to dedicate this work to my wife, Hannah L. Shipley, for her continued and everlasting support, for believing in me, and for always being by my side. I would also like to dedicate this work to my late grandfather, Clifford B. Tatham, for his words of encouragement and sincere interest and heartfelt investment in my education and research.

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CHAPTER 1

INTRODUCTION

Overview

This research explored what morphological traits of bugs might be useful in capturing human attention and instilling situational interest, resulting in positive first impressions of unfamiliar insects and other small invertebrates. For the purposes of this research, we refer to insects and other small land arthropods as “bugs.” This chapter provides a summary of relevant background information, presents research objectives, reviews important terms, and outlines specific research questions.

Background & Problem

The role of outdoor recreation and leisure in the human condition has been the focus of research and practice in the United States for over 60 years. Trends in the health literature reveals ongoing risks from lack of participation in outdoor recreation (Countryside Recreation Network, 2015) compared to the numerous outcomes widely desired by society derived from active outdoor recreation (Pretty, Peacock, Sellens & Griffin, 2005). Likewise, Louv (2008) described a nonclinical disorder (nature deficient disorder) that presents a possible link between the decline in outdoor recreation participation amongst youth in the United States with a rise in health, environmental, and educational deficits. More recently, Louv (2011) presented a rationale for why participation in outdoor recreation and interacting with nature is critical in human development and restoration. Unfortunately, the widely valued outcomes of nature interaction is lost, as over half of the population in the United States indicated that they have not participated in a single outdoor activity during the entire year of 2014 (Outdoor Foundation [OF], 2015). This has left leisure practitioners seeking answers to why people do not participate in outdoor recreation and how non-participants may be potentially engaged to adopt outdoor recreation.

A constraint? Fear and disgust of nature is one of many constraints to outdoor recreation and leisure. Snakes, insects, spiders, large wildlife (bears), and other non-indigenous species (tiger, lion, etc.) are commonly expressed fears of nature. Fear and disgust of nature and a desire for modern comforts have been found to predict preferences for wildland settings and outdoor recreation. (Bixler, Carlisle, Hammitt & Floyd 1994; Bixler & Floyd, 1997). Therefore, fears and disgust of creatures such as insects may negatively regulate motivation to participate in outdoor recreation or to explore wild settings. Some types of bugs can be persistently irritating. This is not surprising, for literature suggests that insects are by far one of the most disliked, disregarded, and despised groups of animals on the planet (Kellert, 1993). Human genetic predispositions prepare us to fear certain insects and other arthropods (e.g., spiders) (Prokop, Tolarovicova, Camerik & Peterkova, 2010), then modern culture and the media manipulates this fear in story lines and news for monetary gain (Lockwood, 2013: Mertins, 1986). The interaction between human predispositions and media manipulation has amplified and instilled an irrational fear of these creatures (Muris, Mayer, Huijding & Konings, 2008). An overwhelming amount of direct negative interactions and a lack of positive experiences often leave people with little motivation to purposeful engage these bothersome, annoying, and seemingly unimportant creatures

Bugs as gateways. Shipley and Bixler (2016) argue that while insects and other land arthropods (bugs) are commonly perceived as unimportant, interactions with bugs may be one of the more critical experiences that needs to occur during middle-childhood to promote fascination with bugs before fear and disgust of them develops. They present a rationale that through offering children a plethora of positive opportunities with bugs, fascination will develop toward bugs and the wild outdoors where bugs are found. Additionally, during a sensitive period that likely occurs during middle childhood, bugs can provide an easily accessible and inexpensive gateway to nature experiences by promoting fascination and curiosity (Shipley & Bixler, 2016). Furthermore, Estren (2012) presents a call to action imploring scientists across disciplines to diversify the focus of social science research to include those creatures that are deemed not-cute (e.g., gross, slimy, creepy, and crawly). Both of these articles suggest that leisure and outdoor recreation practitioners interested in wildland environments are actively setting a standard of ignorance for focusing only on the cute and sexy rather than all aspects of nature.

Bugs and natural history interpretation. In reality, no matter how great the potential opportunities may be, the positive incorporation of insects and bugs into recreation settings remains an arduous task. An evaluation of national and state science standards reveals that very little is emphasized about bugs in formal classroom learning environments (National Committee on Science Education Standards and Assessment, 1996), suggesting that widespread education about bugs is not occurring. This leaves informal learning environments, such as natural history interpretation, as one of the potential channels for people to experience positive interactions with bugs (Bixler, James & Vadala, 2011). Informal natural history interpretation often differs from formal classroom education experiences. Interpretation typically focuses on experiential and affective learning rather than placing a strong emphasis on cognitive-based learning. Interpretation has been found to be an effective method for providing foundational development for positive change (Duvall & Zint, 2010; Tubb, 2003).

Bugs are a great fit. Not only is interpretation a potentially effective method for promoting fascination with bugs, but bugs also fit the goal of providing unique experiences that most interpretive programs strive to offer. Bugs are inexpensive, if not free for the gathering, requiring little food if kept as pets, and are short lived. For the interpretive naturalist, bugs are abundant, providing opportunities to incorporate living bugs into any interpretive talk, workshop, or walk. While a vast majority of children cannot afford to travel to Africa, an interpretive naturalist can always lead youth on an insect or bug safari searching for ant lions and tiger beetles. Opportunities such as these provide for a sense of discovery as well as instilling familiarity and connections with local natural areas. All this suggests that interpretive programs incorporating bugs could be an effective tool for replacing fear of insects with fascination. However, the problem remains that people who are disinterested in bugs are unlikely to attend an interpretive program on bugs. How might this issue be addressed?

Interest and attention. Instilling societal-wide interest in a topic as undervalued and repulsive as bugs is unlikely to occur rapidly. However, it may be possible to create positive situational interest in bugs that could provide the first step to long term interest in bugs. Gast and Skinner (1929) propose that interest and attention are intertwined concepts, that interest guides attention. In his seminal work, James (1890) eloquently describes that:

> Everyone knows what attention is. It is the taking possession by the mind in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought...It implies withdrawal from some things in order to deal effectively with others. (p. 403)

James suggested that attention may be immediate or derived, and passive or active. Attention is labeled as derived and active when the stimulus is interesting in relation to some other preexisting interest a person has. Immediate and passive attention occurs where a stimulus is inherently interesting and is more reflexive. For example, a mountain climber is more likely to give derived and active attention to a magazine about climbing equipment. In contrast, the typical person cannot resist examining a car accident on the highway. This type of attention is immediate and non-voluntary (passive). In regards to bugs, it is hypothesized that by understanding what visual traits are inherently interesting, interpretive naturalists and other visual communication professionals (e.g., magazine editors, public relation advisors, marketers, filmmakers, museum curators, etc.) could present images of bugs so as to create non-voluntary interest. Lastly, in order to maintain attention, visual communication professions should also consider visual perception.

Attention and perception of bugs. Attention is often a product of the human unconscious that brings stimuli into consciousness. Whereas perception is the interpretation of the senses that have been brought into consciousness (Bodenhausen & Hugenberg, 2009). The attention and perception of a stimulus can be broken down into bottom-up and top-down processes. Bottom-up processes often involve the inherently salient traits of the stimulus, while top-down processes typically involve the goal-directed motivation of attention (Bodenhausen & Hugenberg, 2009). To determine the immediate and passive attentive traits of insects, bottom-up processes of attention that are brought into consciousness should be the principle unit of analysis. In contrast, to understand the perception of these traits, top-down processes should be analyzed. Recent advances in technology have promoted many academic disciplines to commonly adopt eye-tracking as a modern advanced methodology (Duckowski, 2002), which allows researchers to measure eye movements, aiding in understanding visual attention mechanisms (Pelz, Canosa, & Babcock, 2000).

First impressions of bugs. Research suggests that the average American is largely unfamiliar with most species of insects (Kellert, 1993). Exposure to bugs during promotional, experiential, interpretive, and other educational programming may often be many American's first impression of many bug species. First impressions have been found to be rapid, lasting, and stable (Digirolamo & Hintzman, 1997; Willis & Todorov, 2006). When dealing with disgust and fear inducing creatures, such as bugs, it may be important for professionals to *judiciously* select which types of bugs should be presented. By manipulating which bugs are presented, negative first and lasting impressions based off of the attention and perception given to these often novel creatures can be avoided.

Creeping and crawling into the unconscious. When encountering unfamiliar stimuli for the first time, the human mind unconsciously and rapidly evaluates, judges, and develops inferences about initial impressions (Kihlstrom, 1987). Attentional and perceptual processes during these interactions are part of first impressions. The conceptual understanding of these unconscious processes can be explained partially by dual-process theory. This theory conceptually divides the human mind into two primary systems. System 1 is unconscious, fast, associative, and requires little effort, while System 2 is conscious, slow, rule-based, and requires high effort (Kahneman, 2011). Therefore, attention and first impressions of unfamiliar stimuli are fast, unconscious, and associative. If unfamiliar bugs are presented without careful consideration, preexisting negative associations may negatively influence the attention and perceptions given the bug or an illustration of it. This process can result in a disregard for a particular bug, thereby inhibiting any additional attention and subsequent perceptual and behavioral interactions.

Research Purpose & Objectives

This research creates a set of heuristics, informing professional judgment as to what specific bugs with what characteristics should be portrayed in any visual medium. Practitioners ranging from environmental educators and interpreters, to marketing, magazine editors, and filmmakers are provided a rationale for what specific morphological characteristics and traits should be visually present in a bug image so as to provoke positive attention and to create situational interest and engagement. By knowing what traits and characteristics of bugs that people find interesting, practitioners can carefully use this information to construct promotional, educational, and play material to entice specific audience reactions and promote positive perceptions. By attracting people without prior interest in bugs to programming and experiences, professionals will be able to reach a more diverse group of participants. Leisure programs that attract non-users and non-traditional users permit opportunities to broaden their experiences, facilitating growth in their understanding of the natural world, and discover that bugs are not as intimidating as they seem. The ultimate goal is more comfort in natural and wildland settings, providing for more diverse experiences during outdoor recreation activities.

Due to extreme negative bias toward bugs, a more strategic and methodical approach must be taken to ensure a positive and remembered first impression of bug related programming. While interpretive and educational programs have the potential to provide for unique and novel experiences, the outcomes will have little effect if negative cultural attitudes constrain audience attendance. If the influence of negative associations on first impressions are to be overcome, or can be at all, then research must first address what and how specific characteristics of bugs are observed and perceived. Specifically, what characteristics are nonconciously observed and attended to by people? By understanding what characteristics are primarily observed, these traits may then be compared to formulate what features are perceived as either positive, negative, or neutral. To address inquires such as “what specific features of a spider cause a person to have a negative reaction”, a multi-faced series of exploratory research questions were examined.

Definitions

Bugs. A common folk taxonomic classification comprised as any land invertebrate excluding crustaceans. Including, but is not limited to, insects, spiders, scorpions, centipedes, millipedes, snails, slugs, ticks, and pill bugs. This definition reflects common folk taxonomies, informal classification systems that differ from the scientific definition of insects as having three body parts and six legs

Types of Bugs. An intermediate categorization of bugs at the taxonomic classification level of "Order" (e.g., Coleoptera (beetles), Lepidoptera (butterflies, moths), etc.). The magnitude of existing families, genera, and species of insects far exceed the research questions of this project. Throughout this manuscript, any bug that is referenced will have a number listed after the name that corresponds with a list of all bug types used in this research, found in Appendix A.

Distractor Animals. A collection of ten animal images from the literature. These animals represent a wide range of preference ratings. This research used kitten, horse, dog, duck, hamster, turtle, toad, mouse, snake, and bat. (Bjerke, Odegardstuen, & Kaltenborn, 1998; Herzon, Betchart, & Pittman, 1991)

Traits. External morphological characteristics and body parts such as the eyes, legs, wings, mouthparts, spines, claws, antenna, segmentations, hairs, banding, etc.

Visual Attention. The mental processing and focus on physical senses (visible light) observed through the eyes.

Foveal Gaze. Gaze directed to put stimulus into focus, specifically centering fixations upon the object or stimulus in line with the fovea of the eye.

Visual Perception. The cognitive and emotional interpretation of focused visual attention.

Area of Interest (AOI), are pre- or post-research defined regions or traits of a visual stimuli where metrics in relation to eye-tracking procedures are drawn. For example, an AOI of a bug may be drawn around the legs, abdomen, head, eyes, wings, etc. Numbers or duration of fixations are calculated and analyzed within each AOI.

Research Questions

The subsequent research questions were address in this research.

RQ #1. Which bugs out of 90 presented types are people who lack an entomological background unfamiliar with? Note that the 90 bug types were chosen to maximize morphological and biological diversity, based on findings from the literature (40 bugs), past research (10 bugs), and expert input (40 bugs).

RQ #2. What predicts familiarity with bugs? For people who lack a background in entomology, how does levels of past experience with bugs, outdoor recreation participation, disgust sensitivity, and locus of control predict overall familiarity with bugs?

RQ #3. Of bugs which are identified as most unfamiliar, which bugs are perceived as being interesting? Additionally, are there different types of interesting bugs?

RQ #4. Of people who lack an entomological background, do different levels of disgust sensitivity, outdoor recreation, prestige, dominance, exploration, and general curiosity predict overall interest in bugs?

RQ #5. What traits of interesting bugs are visually fixated on longer compared to non-interesting bugs?

RQ #6. Do interesting bugs capture more visual attention than non-interesting bugs?

Summary

Insects and other land arthropods (bugs) are generally disliked by the general public. Because of societal wide fears and disgust elicited by these creatures, bugs pose a potential constraint to leisure participation. However, it has been theorized that comfort with bugs may reduce fears of these creatures, ultimately resulting in a person's increased comfort in wild nature. But engaging a disinterested public is challenging. As a method to encourage positive first time experiences with bugs in informal education settings, this research sought to identify bugs which are largely novel and considered interesting by the general public. In the following chapters, a careful examination of the literature will be presented, followed by a detailed methodology, with complementary results and a discussion of findings.

CHAPTER II

LITERATURE REVIEW

Overview

This chapter defines the focus of this research and then summarizes prominent historic research on human interactions with bugs. Next, a rationale for this research is given. Lastly, an overview of the theoretical underpinnings of this research is presented.

The Trouble with Bugs: Focus on the most Abhorred?

While the scientific literature identifies a bug as an insect in the order Hemiptera, there are an abundance of informal or folk taxonomic classification systems for bugs. Shepardson (2002) found that children use the word "bug" as a generic term. Additionally, Shepardson found that kindergarteners regularly identified bugs as being small, bug shaped, with lots of legs and fifth graders identified bugs as small, with three body parts, six legs, antenna, and hard shells. This range of classification suggests that common folk taxonomies are diverse, establishing a need for a precise definition. For the purposes of this research, a bug was considered as any land invertebrate excluding crustaceans. This includes, but is not limited to: insects, spiders, scorpions, centipedes, millipedes, snails, slugs, ticks, and pill bugs. This classification aligns with similar research on human-bug interactions (Byrne, Carpenter, Thomas, & Cotty, 1984; Cranshaw, 2006; Kellert, 1993; Shepardson, 2002)

Interactions with Bugs

The majority of human interactions with bugs are negative (Kellert, 1993; Lockwood, 2013), however it is important to document the extent of variability in human-bug relationships. Typical human interactions with bugs can be parsimoniously dichotomized into positive and negative experiences (Byrne et al., 1984; Schlegel & Rupf, 2010; Schlegel, Breuer, & Rupf, 2015; Wagler & Wagler, 2011). Shipley and Bixler (2017) found evidence that people's general knowledge of insects was limited to bugs that were strongly perceived as negative or positive, with few remembered experiences involving neutral interactions with bugs. While little research has been conducted to examine positive interactions with bugs, Prokop and Fancovicova (2010) found that there were associations between ratings of fear and disgust for bugs, such that levels of fear and disgust varied across groups of species. Breuer, Schlegel, Kauf, and Rupf (2015) grouped bugs with negative affinity scores along fear and disgust scores and found bugs with high disgust scores, high fear scores, and a group of bugs that scored high on both frightening and disgusting scores. There is undoubtedly variation in human attitudes of different groups of bugs. Furthermore, there are individual differences among persons that are helpful in explaining general levels of interest in common and known bugs.

Past research on human-insect interactions have identified patterns that may predict interest in bugs. Several studies have documented that males often report less animosity towards bugs (Byrne et al., 1984; Herzog, Betchart, & Pittman, 1991; Prokop, Prokop and Tunnicliffe, 2008; Schlegel & Rupf, 2010; Schlegel et al., 2015; Snaddon & Turner, 2007). Additional studies have detailed that past life experiences shape preferences for bugs, for instance people with more direct experience with bugs typically find bugs to be more pleasing (Schlegel & Rupf, 2010; Schlegel et al., 2015) along with people who engage in nature-related leisure (Schlegel et al., 2015). There is also evidence to suggest that personality traits such as high disgust-sensitivity is correlated with phobias of spiders and ensuing a general aversion of bugs (Davey, 1994; de Jong & Merckelbach, 1997; Overveld, de Jong, Peters, Cavanagh, & Davey, 2007; Sawchuk, Lohr, Tolin, Lee, & Kleinknecht, 2000).

Additional hypotheses have been made about predictors of familiarity and interest with bugs, such as locus of control, openness to experiences, and desire for social status. Perceived locus of control is often defined as the extent to which a person views events in their life as caused by their own internal actions or as a result of external events outside their own control (Palenzuela, 1988; Sapp & Harrod, 1993). Desire for social status or pride has been conceptualized as hubristic (dominance) and authentic (prestige) (Cheng, Tracy, & Henrich, 2010). Hubristic pride is related to stable concepts such as being proud in one's self, while authentic or achievement-based pride is related to specific achievements (Tracy & Robins, 2004). Openness to new experiences are related with self-regulatory motivations to experience novelty and challenging situations (Kashdan, Rose, & Fincham, 2004). Trait curiosity has been conceptualized as motivation to seek new experiences (stretching) and as willingness to embrace novel experiences (embracing) (Kashdan et al., 2009). Because bugs are typically viewed unfavorably, people with higher external locus of control or higher desire for social status may be less familiar or less interested in learning about bugs. In contrast, people who have high levels of stretching and embracing curiosity traits may be more interested in bugs.

In his typology of basic attitudes towards animals, Kellert (1993), identified that a negativistic viewpoint was the primary belief reported by the general public towards invertebrates. Negativistic attitudes are primary orientations of fear, dislike, or indifference toward invertebrates. Conversely, moralistic and humanistic attitudes towards invertebrates were rare in the general population. A recent study reveals that around 68% of the general public believes that insects are harmful to their family households (Baldwin, Koehler, Pereira, & Oi, 2008). These findings further support the claim that invertebrates are among one of the most feared and hated groups of creatures. Negativistic attitudes towards bugs are also often accepted as normal in American society. Baldwin et al. (2008) found that a majority of homeowners acknowledged that just the visual presence of any insect was motivation to apply pesticides in the home. A summary from Pest Control Technology (PCT, 2015) reports that Americans spent over 7.5 billion dollars in 2014 for pest removal from residential and commercial spaces alone. This excessive spending on pest control suggests that negative attitudes toward bugs may have some dominating influence on the behavior of the typical American in regards to direct interactions with insects. Bixler et al. (1994) found that the most frequently expressed fear among children visiting nature centers were towards snakes and insects. Negative attitudes toward bugs constrain participation to leisure in natural areas. However, a reduction in negative attitudes towards bugs may allow for a more enjoyable experience while in natural areas. Likewise, positive attitudes and interactions may create interest in bugs as a motivation to be outdoors.

New Opportunities with Bugs: Why Focus on Them?

Adaptation-level theory (Helson, 1964) describes judgments as based upon relations to the prevailing norm. Judgments are based upon personal recollections of relevant stimuli. For instance, for a pen to be considered heavy it must weigh more than 4 ounces, while a baseball is judged heavy when it weighs more than 40 ounces. This example suggests that the judgment of a stimulus is constructed from the exposure to closely related stimuli. An example is that an office employee is likely to be more disgusted by a wider range of stimuli contrasted with an employee of a sewage treatment facility. Another example would be that a hiker who encounters a wide range of stimuli in nature should be more impartial about ostensibly adverse objects in natural settings, such as bugs. Adaptation-level theory applies to bugs because bugs may represent a possible extreme of fear inducing stimuli commonly found in nature settings. Concluding that familiarity and exposure with disliked bugs may reduce the overall fear experienced by people while in natural settings, thus reducing a possible constraint to leisure participation. However, opportunities to provide for repeated positive exposure with bugs are minimal.

An examination of science standards reveals that very little is emphasized about bugs (National Research Council, 1996), suggesting that the average classroom setting does not provide for adequate experiences with insects. This leaves informal interactions as the primary mechanism for bug experiences. Common informal interactions with bugs can be categorized into two primary experiences, cultural and direct. In the United States, culture has greatly influenced human perceptions of bugs through the presentation of disgust and fear evoking stimuli in media, primarily through movies, television shows, and news. Mertins (1986) found that from 1908 to 1984, only ten movies depicted bugs in a positive style, while 60 movies depicted bugs negatively. Aside from the occasional positive experience (e.g., encountering a pretty butterfly) most direct informal interactions with bugs are likely negative. Of the negative interactions had with bugs, most are with just a few species that bite, sting, and invade personal space. Alternatively, a potential type of positive and direct informal interaction with bugs can occur through the participation in environmental education and interpretive programs.

Environmental education and interpretive programs have been found to be a somewhat effective means of distributing knowledge and awareness of specific resources (Ballantyne, Fien, & Packer, 2001; Orams, 1997; Tubb, 2003). These programs provide experiences that are not attainable in a classroom setting. These informal programs have the capacity to provide for positive interactions with bugs in an enjoyable manner. Through enjoyable programs, people can experience bugs in an engaging, emotional, and meaningful way.

One way that programs, recreation, and leisure programs may incorporate bugs is by focusing on their unexpected playful qualities. Laurent (2000) examined Japanese culture and found that children and hobbyists alike raise bugs as pets. Laurent also identified various activities that both Japanese and American children participated in such as playing with and observing bugs, while Japanese children listened to, collected, and bred bugs for leisure. Insects such as crickets, grasshoppers, stag beetles, rhinoceros beetles, and silkworms are all sold for play and enjoyment purposes in Japan. Lemelin (2007) further examines the role of dragonflies in Asian counties, where he suggests that dragonfly enthusiasts pride themselves on recognizing many different species of dragonfly, just like bird watchers in western cultures. These activities identified by Laurent and Lemelin can be readily adapted to use in informal and nonformal nature settings in the United States for programming, recreation, and leisure purposes.

While playful qualities of programs may better engage audiences, user attendance of programs involving bugs may present a potential constraint due to negative preconceptions that extinguish initial appeal. Because participation in non-formal learning and educational programs is often voluntary and self-selected, people who are uninterested in bugs are unlikely to purposefully interact with bugs, subsequently reducing motivation to pursue bugs as leisure and recreation pursuits. Insight on how to better engage audiences with bugs may be gained through understanding morphological characteristics of bugs that are appealing. By presenting these creatures in a way as to enhance their appeal, it may be possible to increase intrinsic motivation of people to interact with bugs in leisure settings.

Bugs Made Appealing: Interest and Curiosity

Interest has been suggested as a crucial determinate for motivation and memorability of stimuli (Hidi & Baird, 1986). Where the "interestingness" of an object or stimuli originates from two primary sources, inherent traits of the stimuli that are universally interesting or directed interest dictated by a person's past experiences. Hidi and Baird describe two types of interest, cognitive and emotional. They argue that interest is developed during situations that are surprising, abnormal, novel, or unexpected. Additionally, interest may reinforce the comprehension and recall of learned information. This suggests that stimuli that are inherently surprising, abnormal, or novel may likely induce interest in a person. Furthermore, Loftus and Mackworth (1978) proposed that interest is important in visual processing, suggesting that a visual stimulus can be presented in a purposeful way as to capture the interest of the person.

Berlyne (1966) suggests patterns that stimulate "perceptual curiosity" tend to be more interesting to persons. Perceptual curiosity is the combined stimulus traits of novel, surprising, complex, or ambiguous patterns. Berlyne defines curiosity as the condition of discomfort due to inadequate information motivating specific exploration. Kashdan, Rose, and Fincham (2004) proposed that curiosity may be one element in the development of interests, suggesting that stimuli that promote curiosity may motivate exploration. Therefore bugs which are novel, surprising, or complex in their traits may induce a high degree of inherent curiosity in viewers. Thus, certain bugs could be potentially situationally interesting. By understanding what these traits are, visual communication professional can select bug traits that promote situational interest.

The Instinctive Bug Impression: The "Buggy" Traits

The literature suggests that judgments of affinity or fear of bugs can be made almost entirely on external morphology of a bug. Wagler and Wagler (2012) found that preservice elementary school students expressed a decreased likelihood of incorporating insects into classroom curriculum after being shown images of insect larval forms, which are often perceived as disgusting. The same students then expressed an increased likelihood of incorporating insects into the classroom after being shown images of adult forms of the same insect species. In relation to attention, Riskind and Maddux (1993) found that the perceived degree of loomingess (i.e., the appearance of being threatening) in a spider was related with the perceived fear. However, this study did not explore the interaction of specific morphological traits that promoted a perception of fear, suggesting need for a more systematic analysis. Additionally, much of the existing research has only examined the negative characteristics of bugs, such as ugliness and sliminess, rather than the potential positive and neutral traits inherent in some bugs (Bennett-Levy & Marteau, 1984; Gerdes, Uhl, & Alpers, 2009). Furthermore, Estren (2012) discusses the "neoteny barrier." how humans unconsciously display a tendency to prefer animals that display neotenic characteristics (i.e., large heads, large eyes, small nose, and short limbs). Bixler, Crosby, Howell, and Tucker (2015) found that jumping spiders were perceived as "less scary" when compared to other spiders. This reflects the jumping spider's neotenic traits of large forward facing eyes, small "chin" and short legs. This study demonstrates new insight into how bugs are perceived primarily through unconscious processes, suggesting potential for further exploration of the unconscious influences of perceptual characteristics of bugs.

While morphological traits of bugs have been found to influence perceptual judgments, literature suggests that these judgments are biased by a lack of overall awareness of these creatures. Kellert (1993) reported that 70 percent of respondents were not aware that caterpillars are more closely related to beetles than earthworms (i.e., earthworms are in the Phylum Annelida, evolutionarily distant from Arthropoda) and only 23 percent of respondents were aware that spiders are not insects (i.e., spiders are Arachnids). Additionally, it was found that students in an elementary school from the Midwestern United States did not consider butterflies to be insects based off of perceived morphological traits (Shepardson, 2002). In a recent study of college students, Shipley and Bixler (2017) found that students could only name 13 mean species of bug in an open-ended questionnaire. This finding suggests that most people are unlikely to be familiar with most species of bugs that are encountered while in nature settings (i.e., there are more than 82,000 described species of insects in North America) (Sabrosky, 1953). These empirical works support the assertion that most judgments of bugs are based largely upon the knowledge of just a few species, which are the species that seemingly seek out people to bite, sting, or suck blood. When exposed to insects that are not out to bite us or are inherently beautiful (e.g., butterflies), it is likely that human visual attention and perception of these species will likely be constructed based on first impressions.

First impressions are fast perceptions of novel stimuli. Lindgaard, Fernandes, Dudek, and Brown (2006) found that visual first impressions can be constructed from just 50 milliseconds of exposure. Digirolamo and Hintzman (1997) found that first impressions establish a representation that is activated by subsequent presentations, suggesting that negative perceptions of novel stimuli will result in continued negative appraisals. In the presentation of unfamiliar stimuli, these findings support thoughtful consideration and selection of bug traits in the visual presentation of bugs. Furthermore, Kihlstrom (1987) discusses the mediated role of unconscious processes on first impressions, operating outside conscious awareness at an automatic level. This discussion supports the need for consideration of unconscious measures to examine the influences of bug traits on first impressions, in order to better explain and understand how first impressions of novel traits catch attention, influence perception, promote curiosity and interest, and may ultimately motivate behavior.

Attention, First Impressions, and the Adaptive Unconscious

Morphological traits of bugs that are perceived negatively may instantaneously decrease personal curiosity and interest in the presented bug. Fear and disgust are two negative traits that are recognized in the literature as primary deterrents to interacting with bugs. Muris et al. (2008) found evidence to suggest that perceived disgust can influence the fear associated with specific bug species. The authors suggest that differences in fear and disgust ratings of various species support an evolutionary explanation for these traits in human perceptions of bugs.

Seligman (1971) was the first to suggest that phobias are "prepared" in human learning, where phobias resist change and can be acquired in one experimental conditioning trial. These prepared fears involve biologically significant stimuli that were likely important to the survival of early humans. Preparedness suggests that fear of dangerous and disease borne organisms has an evolutionary origin. Evolutionary psychology suggests that psychological mechanisms have evolved to serve specific functions. Dispositions to fear spiders and other bugs results in an avoidance of situations that could lead to infection, disease, or death (Buss, 1995). Additional evidence suggests that these evolutionary fears are innate, do not apply only to phobias, can apply to specific perceptual characteristics of bugs, are likely noncognitive, and resistant to cognitive intervention (Bennett-Levy & Marteau, 1984; Öhman & Mineka, 2001; Seligman, 1971).

Non-cognitive or unconscious processes are dichotomized with cognitive processes in dual process theory. Dual process theory attempts to explain variation in human decision making and divide various mental processes into two primary systems, commonly referred to as System 1 and 2. System 2 is primarily conscious reasoning, which is slow and rule-based, permitting abstract hypothetical thinking. System 1 processes are unconscious, rapid, and automatic in nature, based on associative learning (Evans, 2008). Applying dual process theory to evolutionarily prepared fears suggests that fear of spiders (bugs) is initially a largely unconscious processes. Fear evoked from these creatures elicits a rapid and automatic response outside conscious control. As Seligman (1971) hypothesized, prepared fears are resistant to cognitive intervention. Additionally, dual process theory suggests that the automatic process of System 1 are unattended by System 2 processes, where it is only the final product of System 1 that is received by overt cognition. This suggests that to best understand human attention and perception of bugs, unconscious processes of the brain ought to be the subject of inquiry rather than explicit measures.

Measuring Attention

A recent advancement in research technology has been the development of eye tracking apparatuses, which measure the point of foveal visual gaze and fixation derived from angular eye movement (Guestrin & Eizenman, 2006). The theoretical underpinning is that foveal gaze on a singular specific region in space reveals where mental attention is focusing. However, attention may not be limited to just foveal gaze. Mind wandering or peripheral vision may be where the focus of attention is during a moment in time. Despite these issues, the assumption remains that measuring foveal gaze is a proxy for mental attention (Duckowski, 2002). Attention is the allocation of finite mental resources to process specific information in full detail while ignoring much of the present situation or environment (Parkhurt, Law, & Niebur, 2002). Specifically, attention is defined by a limited capacity to process all sensations as a given moment, while also serving as a "filter" that passes over nonessential information (Broadbent, 1958; Desimone & Duncan, 1995). Attention can be further dichotomized as bottom-up and top-down attentional mechanisms. Bottom-up attentional mechanisms are quick and mostly stimulus driven, while top-down mechanisms are slower and goal driven by an individual's expectations or objective (Parkhurst, Law, & Niebur, 2002). In some circumstances, high salience traits inherent of a stimulus (e.g., police flashing lights and sirens) may enact bottom-up attentional mechanisms such that the stimulus "captures" attention (Buschman & Miller, 2007).

Visual attention is what is observed through the eyes, either as a metaphorical "spotlight" where attention is limited around a specific circular range (Ponser, 1980) or as a “zoom-lens” where the circular diameter can grow or shrink to include or exclude detail (Erikson & St. James, 1986). There are two visual processing pathways in the human brain, identified as the “what and where” or the “ambient and focal” visual pathways (Creem & Proffitt, 2001; Rueckl, Cave, & Kosslyn, 1989; Trevarthen, 1968). Research on both visual pathways suggest a difference in eye movements and fovea gaze as a result of the “what and where pathways”. Velichkovsky, Joos, Helmert, and Pannasch (2005) found evidence that identified short fixations followed by long amplitude saccades as ambient visual processing while longer fixations followed by short saccades were found to be focal visual processing. Extensive research has demonstrated that during visual search in a scene, the first few seconds of visual fixations are made through the ambient pathway, quickly scanning salient structures of the image followed by slower focal processing on important areas through the focal pathway (see Unema, Pannasch, Joos, & Velichkovsky, 2005, for a more detailed review). This research suggests that fixations made during the first few seconds of scene visualization are more reflective of the salient stimulus traits that capture more bottom-up or unconscious attention while later focal fixations are more reflective of top-down goal directive attention.

Loftus and Mackworth (1978) suggest that attentive characteristics of a stimuli may be identified through the underlying psychological mechanisms of visual attention. Measuring attention through foveal gaze fixation is considered an ecologically valid measure (Hermans, Vansteenwegen, & Eelen, 1999; Rayner, 1978), suggesting that visually attentive traits of a stimuli can be identified and evaluated through foveal eye fixation measurements. An example comes from two seminal studies, each found evidence to suggest that people preferentially fixate on other people and faces in static images or scenes (Buswell, 1935; Yarbus, 1967). These works were some of the first to indicate that visual fixation can be used to indicate an observer's preference.

Fixations of the eye have been analyzed through a number of different techniques since the 1800's. More recent advancements in eye tracking provides modern hardware that can capture eye movements through the use of video recording sensors. Common optical video-based eye trackers typically employ video cameras and infrared illuminators in front of the participant's eyes to record corneal reflections and calculate the location of visual gaze. Modern eye tracking equipment has the capacity to sample eye measurements faster than every millisecond, providing the precise duration of saccadic eye movements and visual fixations (Wang, 2011). Additionally, eye tracking methodology has been applied across disciplines in the fields of neuroscience, psychology, engineering, human factors, and marketing (Duchowski, 2002), where this advanced technology has proven to provide ecologically valid and reliable data. Through the use of eye tracking devices, researchers are able to determine what participants are looking at and where users are allocating their attention or inattention. This suggests that eye tracking methodologies can be applied to understand what traits of bugs receive cognitive attention. However, eye tracking and visual attention often provide ambiguous results in regards to the subjective experience of the participant, suggesting a need for additional considerations.

Measuring Perception

One consideration to understanding how a person processes visual attention is the related concept of visual perception, or how the person individually and uniquely interprets and internalizes a stimulus (Bodenhausen & Hugenberg, 2009). Isaccowitz, Wadlinger, Goren, and Wilson (2006) provided evidence that eye tracking can identify attentional preferences towards selected stimuli. Furthermore, increased duration and number of fixations on a stimulus is often related and predictive of more positive evaluations (Maner et al., 2003; Maughan, Gutnikov, & Stevens, 2007), allowing researchers to infer subjective preference. Isaacowitz, Wadlinger, Goren, and Wilson (2006) subsequently propose that motivation directs gaze, that a person will direct gaze towards emotional information and stimuli that match the user's emotional state. Additionally, Balcetis and Dunning (2006) suggest that motivations, including those primed implicitly or precociously, influence a person's attention towards a desired emotional stimuli. These findings suggest that perceptual characteristics in regards to emotional and motivational desires direct the user's gaze, or the location where the user is fixating visual attention. Applied to traits of bugs, perception and foveal gaze may reveal traits of bugs that are desired or preferred.

A second consideration is the conscious, System 2 evaluation of visual perception through self-report measures. Eye tracking analysis can reveal what specific elements of a visual stimulus receive the most attention. However, this does not reveal the participants assigned value or preferences across stimuli. One solution is to assess different emotional responses and ratings in relation to specific traits of bugs that attention measures have already identified. Following a mixed-method methodology for assessing visual processes, eye-tracking measures can identify objective data (e.g., number or duration of fixations) while subjective self-report data (e.g., differential emotion scales) can be used to assess perception (Wiklund-Engblom & Högväg, 2014). As discussed earlier, fear and disgust are two primary emotions that are often related to perceptions of bugs. Both emotions have been found to activate different regions of the brain, suggesting the difference between these two concepts, thus the need to measure each independently (Thielscher & Pessoa, 2007). Of the identified ten basic human emotions (Izard, 2013); pleasantness, surprising-ness, and interesting-ness, along with fear and disgust, seem to be applicable emotions to assess in visual perception as to understand the perceived novelty, surprise, and complexity underlying curiosity and interest of bugs.

A final consideration is analysis of duration spent on image evaluation. Lang, Greenwald, Bradley, and Hamm (1993) found evidence suggesting that the amount of time spent looking and engaged with a stimulus was correlated with curiosity. Applying this measure of curiosity with foveal gaze and self-report measures should reveal how traits of bugs may influence first impressions of unfamiliar species. Additionally, specific external morphological traits will be assessed, providing considerations for natural history professionals and other visual communication professional in regards to what images of bugs should be presented in visual promotional and educational material as to motivate situational interest and promote behavior.

Summary

Human-bug interactions are largely negative, leaving people with little motivation to seek out and interact with these creatures. Furthermore, overall familiarity with bugs appears to be extremely low in comparison to the relative abundance of local and common species. By examining what traits of bugs are viewed favorably and identified as interesting, practitioners can create visual media as a potential avenue to motivate perceptual curiosity and stimulate situational interest. The subsequent chapter presents a detailed methodology, covering a series of studies which sought to first identify and differentiate between familiar and unfamiliar bugs, identify and categorize the subjective perceptions of insects, and examine the specific traits of bugs that capture visual attention.

CHAPTER III

METHODS

Overview

To understand and examine the attentive and perceptual characteristics of novel and interesting bugs, six research questions were developed to explore the hypothesized phenomena. A series of four sequential and integrated studies were conducted to address the research questions. The first study sought to establish what bugs are widely known by the general public, as a majority of citizens in the United States are largely unfamiliar with the majority of common bugs (Shipley & Bixler, 2017). The second and third study evaluated perceptions for unfamiliar bugs identified in the first study. The second study consisted of verbal interviews while the third study implemented a researcher-defined systematic empirical survey. The final study evaluated attentive traits of bugs by tracking foveal gaze via eye tracking and determine if morphological traits of previously identified perceptually interesting unknown bugs differed from non-interesting bugs. Following the chapter introduction is a brief description of each of the four studies, detailing the research questions and procedures. After the summary of studies, a systemic description of participants, survey design and development, method procedure and implantation, and preparatory data analysis is presented for each subsequent study.

Summary of Research Studies

The purpose of Study 1 was to identify bugs that the average (non-entomologist) person is unfamiliar with (RQ #1). A total of 90 bug types were chosen based on findings from the literature (40 bug types), past research (five positive valanced and five negative valanced bug types), and expert input (40 bug types). Participants also responded to a locus of control scale, a desire for modern comforts scale, reported subjective level of outdoor affinity and basic demographic information. Reported data were used to predict familiarity with bug types (RQ #2). The purpose of Study 2 was to gain a robust understanding of emotional perceptions in response to different bug types. This study involved semi-structured in-depth interviews using 45 images of bugs used in Study 1. Findings informed the design of Study 3. The purpose of Study 3 was to provide a quantified explanation for specific bug types identified in the previous studies. Each bug was rated on a Likert-type scale along a 1 to 7 or 1 to 5 point increment for each item (RQ #3). Participants responded to a disgust sensitivity scale, a dominance-prestige scale, an exploration-curiosity scale, and reported basic demographic information and outdoor recreation participation frequencies. Reported data were used to predict "interestingness" scores for different bug types (RQ #4). The purpose of the final study, Study 4, was to identify what traits of bugs are most attended to (e.g. antennae, legs, eyes, etc.). Data were used to infer what traits of bugs captured visual attention (RQ #5). This study also compared the "most interesting" and "least interesting" bug types as determined by Study 3 (RQ #6).

Study 1 – Unknown Bugs

Participants. Data were collected from "workers" on Amazon's Mechanical Turk (AMT) (n = 216). AMT provides access to an online work force who are quickly recruited and provide data that is considered as reliable as traditional sampling techniques (Buhrmester, Kwang, & Gosling, 2011) (See Procedure & Implementation for a thorough discussion on the usage of AMT for survey research). Participants were rewarded with $2.00 for completing the 20-minute survey. The amount paid follows ethical recommendations from (Brawley & Pury, 2016) which suggest paying respondents at or above minimum wage. The sample was equally distributed between genders (49.5% female), predominantly white (80.5%), well-educated (43.3% reported having a Bachelor's degree or higher), and ages ranged from 18 to 70 (*M* = 35.3, *SD* = 10.5). (See Table C.1 in Appendix C for a summary of demographic information for Study 1).

Data Instrument & Development. The survey instrument consisted of 100 images of different bug types and other vertebrate animals. Ten images consisted of vertebrate distractor animals (kitten, horse, dog, duck, hamster, turtle, toad, mouse, snake, and bat) (Bjerke et al., 1998; Herzon, Betchart, & Pittman, 1991), these images provided the equivalent of a comparison group typically used in social science research. Five images of bugs were selected that represent bug types that are widely regarded as positive (e.g., butterfly and ladybugs) and five other images that are widely regarded as negative bug types (e.g., spider and mosquito) (Shipley & Bixler, 2017). These bug images provided for an additional comparison group. The remaining 80 bug images were chosen through a sequence of expert review and a systematic diversification of bug types. Shipley and Bixler (2017) asked professional entomologists and hobbyists to identify bugs types that they see and enjoy interacting with when they are in the woods or other natural settings, aside from the commonly identified beautiful and bothersome iconic bugs identified by Shipley and Bixler, 2016. Over 120 bug types were identified through these recommendation and 80 were purposefully chosen for the study to reflect the biological diversity of bug types visible to the naked eye found through the United States.

All images used in the study were full color and high resolution. Images of bugs used in this study were purchased for rights and usage from the Digital Museum of Natural History. Images of vertebrate distractor animals were obtained online through a creative commons license. All images were edited to depict the animal on an all-white background. The relative size of the animal was set to about 50% of the total image size (1900x1100 pixels). A majority of images displayed a side view of the animal (exceptions being a few bug types where a side angle view could not be found, e.g., earwig, cockroach, eyed-click beetle, etc.) Lastly, all images were formatted to depict the animals head and body facing the left side of the image (see Appendix A. for all images used in this study). Orienting the image stimuli to face the same direction controlled for orientation effects and directional bias (Foulsham, Gray, & Nasiopoulos, & Kingstone, 2013; Foulsham, Kingstone, & Underwood, 2008).

Images were sequentially presented to participants with a series of three questions per image. The first question was a single item ‘How well do you know the animal above?’, response categories were on a 5 point Likert-type scale, with 1 being “Not at all familiar” and 5 being “Extremely familiar” (Revilla, Saris, & Krosnick, 2013; Weijters, Cabooter, & Schillewaert, 2010). The second question was a single item ‘How often do you see the animal above?’, response categories were on a 5-point Likert-type scale, with 1 being “Have never seen,” 2 “Have seen before on TV, in movies, or other media,” 3

“Have seen before in a zoo or cage,” 4 “Have seen before around or in my home,” and 5 being “I see it all the time.” Lastly, the final question was an open-ended response question, ‘What do you call the animal above?’ Participants were encouraged to guess the animal name if they were not certain and the option of “I don’t know” was available. The last question provided as a measure of validity as well as provided insight into participant’s perceptions and knowledge of bugs.

Upon viewing all 100 images, participants then responded to a scale questions, reported past experiences with bugs, and reported demographic information. Scale items were chosen to explore RQ #2, examining possible participant individual differences that would predict higher overall familiarity with bugs. Scale items included a nine-item locus-of-control scale and an eight item desire for modern comforts scale. Four questions concerning past experiences with bugs were asked. The first question was ‘Do you consider yourself to be an “outdoorsy” person’ with response categories of 1 for “Definitely not” to 7 for “Definitely yes.” Two questions were asked ‘Did you ever make an insect collection in school or college’ and ‘Did you ever take an entomology course in school or college.’ Respondents responded “yes” or “no.” The final frequency question was an open-ended question, ‘List all the different ways that you have learned about insects and other bugs.’ Basic demographic information consisted of age, gender, level of education, and race.

Shipley and Bixler (2017) found that a disgust scale operationalized around a desire for modern comfort was significantly correlated with interest in bugs. Because a desire for modern comfort may predict interest in bugs, it was hypothesized that a similar scale might also predict familiarity with bugs. The desire for modern comforts scale was modified from Bixler and Floyd (1997). The scale consisted of eight items. The scale had one question that asked participants to, ‘Image that you will spend three weeks living like the early settlers lived, riding in a horse drawn wagon, cooking over an open fire, and sleeping outside on the ground. Below is a list of modern conveniences that you **will not have** during your trip. Please describe how much you would miss each convenience.’ Response categories were on a 1 to 5 scale, 0 for “Would not miss” to 5 for “Can’t live without.” The items were ‘sleeping indoors,’ ‘bathtub or shower,’ ‘flush toilet,’ ‘television,’ ‘insect repellent,’ ‘telephone,’ ‘running water,’ ‘flashlight.’ Following the steps conducted by Bixler and Floyd (1997) a principle components analysis with a varimax rotation was conducted and produced two factors. ‘Sleeping indoors’ was removed due to cross loading on both factors. Factor 1 was labeled as Indoor Comforts (eigenvalue = 2.65, percentage variance = 28.43%, Cronbach’s alpha = 0.73, mean inter-item correlation = .469) and factor 2 was labeled as Technology Comforts (eigenvalue = 1.18, percentage variance 26.38%, Cronbach’s alpha = 0.61, mean inter-item correlation = .28). A regression score for each factor was calculated for each respondent.

The locus of control scale used in this study was a validated brief version of Levenson’s Locus of Control Scale (Sapp & Harrod, 1993). The scale consisted of nine items. The question asked participants to ‘Please rate how each of the following statements describes you’. Response categories were scaled from 1 to 7, 1 for “Strongly disagree” and 7 for “Strongly agree.” Items were ‘My life is determined by my own actions,’ ‘I feel like what happens in my life is mostly determined by powerful people,’ ‘I am usually able to protect my personal interests,' 'Often there is no chance of protecting my personal interests from bad luck happenings,' 'My life is chiefly controlled by powerful others,' 'When I get what I want, it's usually because I'm lucky,' 'To a great extent, my life is controlled by accidental happenings,' 'I can pretty much determine what will happen in my life,' and 'People like myself have very little chance of protecting our persona interest where they conflict with those of strong pressure groups.' The scale items measure three validated latent variables (internal, chance, and powerful others) that load onto a single factor representing the construct of locus of control. Following Sapp and Harrod (1993) a principle components analysis with a promax rotation produced a single factor (eigenvalue = 5.30, percentage variance = 58.84%). Cronbach's alpha for each subscale was adequate, internal (Cronbach's alpha = .77, mean inter-item correlation = .55), chance (Cronbach's alpha = .84, mean inter-item correlation = .63), and powerful others (Cronbach's alpha = .85, mean inter-item correlation = .66). A single regression score for the locus of control factor was calculated for each respondent and individual items were retained to be used in analysis.

Procedure & Implementation. Data were collected online via Amazon's Mechanical Turk following IRB approval (IRB2016-241). Originally regarded as an online micro task marketplace, AMT has become an online convenience sampling source for the social sciences. AMT has been found to be a reliable and representative sample pool with comparable demographics to the general public (Berinsky, Huber, & Lenz, 2012). Additionally, recent studies conducted through Amazon's Mechanical Turk has produced robust results that are often resilient to errors common in other modern survey techniques (Paolacci, Chandler, & Ipeirotis, 2010) (For a more systematic examination of the strengths and weaknesses of using AMT, see Paolacci et al. 2010).

Following recommendations from Brawley and Pury (2016) there are several considerations to using Mechanical Turk as a sample population. First, as with most survey research, this study was conducted in a manner which treated participants fairly. The description of the survey clearly indicated that there were no right or wrong answers and that this survey is not about accuracy. The instructions in the survey asked the participants to not look up the identification of bugs they do not know. The survey stated that participants could only complete the survey once for payment. Lastly, the survey indicated that it contained attention checks. Attention checks or instructional manipulation checks are a method to reduce poor survey responses. Attention checks lure participants but instructs them to answer with a specific single answer regardless of the initial question. If the respondent does not respond as directed, the response is removed (Hauser & Schwarz, 2016). The survey informed participants that if they failed an attention check the survey would close and they would not receive payment. Following general recommendations to ensure reliable and quality data collected through AMT, only AMT workers who had completed more than 500 previous assignments with a 95% satisfaction rating were invited to participate in the study. Additionally, participants were only allowed to participate if they lived within the United States to ensure findings could better be generalized to people who live in the United States.

AMT utilizes a system where tasks are assigned as HITS. The HIT for this study was titled “Familiarity with critters: What is that? (Survey, no more than 25 minutes).”

The description of the HIT was “We want to know what different animals you know!” The keywords for the HIT were “survey, animals, birds, reptiles, fish, critters, bugs, insects, knowledge, research, study, know, familiar, photo.” When respondents clicked the HIT, they were asked to follow an external hyperlink that directed them to an online survey that was conducted using Qualtrics. The Qualtrics survey consisted of two sections. The first section had participants sequentially view each of 100 images. Images were randomly presented to the participant. There was no time limit but participants were encouraged to view the images quickly. The second section of the survey consisted of the scale items, experiences with bugs, and basic demographic information. Following completion of the survey, participants were presented a unique identifier code and directed back to the AMT HIT. Once back at the HIT, participants entered the unique identifier code which was subsequently used to ensure the participant had actually competed the survey. Upon initial review of the data to ensure the survey had been completed, participants were paid electronically through the AMT interface.

Data Analysis. Data were cleaned, organized, and analyzed using IBM SPSS statistics version 23. Exploratory factor analysis was applied to scale response items. A k-means cluster analysis was used to group bugs according to familiarity scores. ANOVA and linear regression were conducted to predict average familiarity scores across clustered bug groups. Descriptive data were used to identify and describe the most and least familiar bugs, identifying the unknown bugs to be used in the consecutive studies.

Study 2 – Perceptions of Bugs: Interviews

Participants. A convenience sample (n = 15) of predominately students (93%) at Clemson University volunteered to participate in a short interview (min interview was 18 minutes, max interview was 55 minutes, average time was 29 minutes). Participants were mostly white (80%), seven were female (47%), and ages ranged from 19 to 35 years old (M = 22.13, SD = 4.44).

Interview Development & Procedure. Images of 45 different bugs were shown to participants. Images were selected based on groupings of familiar and unfamiliar bugs identified in Study 1 (see Study 1 Results for more on grouping method). Bugs were proportionally and systematically selected from each familiarity grouping to ensure that maximum variation in external morphological traits of bugs were present in the images. Twenty-five of the 45 images were selected from the "Unknown" bug grouping, 13 from the "Unfamiliar" group, five from the "Familiar" group, and two from the "Known" group (see Table 3.1 for a list of all bug names used). Bugs from the Familiar and Known group were included in the study to provide as a basis of compassion with Unfamiliar and Unknown bugs (It is also important to note that the bugs selected for this study are also the same bugs subsequently used in Study 3 and 4). Images shown to participants were the same images shown in Study 1, such that each bug was facing to the left and on a white background. While it is common in research to remove color from images to minimize the influence of color in visual appraisals, it was determined that images would be show in full color in order to maximize the ecological validity of the research. Following the conceptual approach to ecological visual perception (Gibson, 2014) it was concluded that color was perceptually important information that is present in real world situations. To extend and generalize findings from this, and subsequent studies, all images shown were displayed in full color.

Table 3.1

Bugs used in Study 2, 3, and 4

Bug Name	Grouping	Bug Name	Grouping	Bug Name	Grouping
Praying Mantis (69)	Known	Robber Fly (73)	Unfamiliar	Giant Ichneumon Wasp (32)	Unknown
Butterfly (4)	Known	Two-striped Planthopper (94)	Unfamiliar	Pelecinid Wasp (65)	Unknown
Millipede (56)	Familiar	Termite (88)	Unfamiliar	Sharpshooter (78)	Unknown
Scorpion (76)	Familiar	Velvet Ant (96)	Unfamiliar	Moth (61)	Unknown
Fly Bee Mimic (30)	Familiar	Cicada (11)	Unfamiliar	Tailless Whip Scorpion (87)	Unknown
Spider (84)	Familiar	Dobsonfly (18)	Unknown	Cactus Bug (5)	Unknown
Dragonfly (20)	Familiar	Grasshopper (34)	Unknown	Weevil (99)	Unknown
Earwig (24)	Unfamiliar	Mantidfly (53)	Unknown	Plant bug (68)	Unknown
Stag Beetle (86)	Unfamiliar	Giant Water-bug (33)	Unknown	Shiny Flea Beetle (80)	Unknown
Pillbug (67)	Unfamiliar	Red-banded Leafhopper (71)	Unknown	Milkweed Bug (56)	Unknown
Katydid (45)	Unfamiliar	Tiger Beetle (90)	Unknown	Saddleback Caterpillar (74)	Unknown
Longhorn Beetle (50)	Unfamiliar	Assassin Bug (2)	Unknown	Antlion (1)	Unknown
Hercules Beetle (37)	Unfamiliar	Spiny Backed Orb-weaver (85)	Unknown	Scorpionfly (77)	Unknown
Hickory Horn Devil (38)	Unfamiliar	Eyed-click Beetle (27)	Unknown	Monkey Slug (59)	Unknown
Sand Wasp (75)	Unfamiliar	Emerald Ash Borer (25)	Unknown	Lacewing (47)	Unknown

Note. The numbers after each bug correspond with the classification system of all bugs used in this research. Images of each bug can be found in Appendix A.

Following IRB approval (IRB2016-299) participants were informally approached by the researcher and asked if they would be willing to participate in a short interview involving pictures of wildlife. Images shown to participants were printed in high detail on an $8^{1/2}$ x 11 piece of high quality card stock. All images were shuffled and randomized before the interview as a method to reduce ordering bias. During the interview, the participant was handed the stack of images and asked to view them sequentially. For each image, participants were first asked the question "what stands out most about this bug?" Follow up questions to participants probed for their subjective feelings and perceptions about each image (bug type). Typical follow up questions asked the participant to explain their perceptions in additional detail, allowing participants an opportunity to provide additional input about the bug. Interviews were recorded on a digital recording device. The interviews were concluded by collecting demographic data on age, gender, and whether the participant was a student.

Data Analysis. Data were coded and sorted. Themes generated from subjective emotional reaction were identified for each bug type. Themes were used to begin disaggregating bugs into unique groups. Results from this study guided the type of emotional questions asked in Study 3. Data from this study were also compared with quantitative data from Study 3 to identify the degree of consistency of findings across studies and methods.

Study 3 – Perceptions of Bugs: Scales

Participants. Data were collected from "workers" on Amazon's Mechanical Turk (AMT) (n = 308). Participants were rewarded with $3.50 (US dollars) for completing the 30 minute survey. The sample was 41.6% female, predominantly white

(82.1%), moderately-educated (41.2% reported having a Bachelor's degree or higher), with ages ranging from 18 to 74 (M = 36.72, SD = 10.99). (See Table F.1 in Appendix F for a summary of demographic information for Study 3).

Data Instrument & Development. The survey instrument consisted of two sections. The first section incorporated 42 of the 45 images of bugs used in Study 2. The image of the lacewing (47), cactus bug (5), and the sharpshooter (78) were removed from the collection of images and replaced with three distractor images. The images were removed to make room for the distractor items without increasing the effort required of participants during the survey procedure. The three bug types were chosen to be removed from the collection of bug images because they did not contribute additional general morphological diversity within the images. Rather than using the same distractor animals from Study 1, images of the three most popular and famous Pokémon were used. Pokémon were chosen because previous research had documented that that young children can more easily identify more Pokémon than native wildlife (Balmford, Clegg, Coulson, & Taylor, 2002). These images served as cognitive anchors or as a comparison group instead of the wildlife images used in Study 1. The three Pokémon were displayed on a white background in a similar layout as the other images of bugs. The Pokémon used were Pikachu, Mewtwo, and Charizard, (see Figure 3.1 for pictures) which represented the three most iconic Pokémon based on an examination of online ranking websites (e.g., gamefaqs.com, dorkly.com, and ranker.com).

Figure 3.1. Pokémon stimuli. Clockwise from top left; Pikachu, Mewtwo, and Charizard.

All 45 images were sequentially presented to participants. For each image, the same six questions were asked. The six items were asked to gather general emotional responses based on findings from relevant literature and findings from Study 2. Two of the questions were a general measure of interest. The purpose of this study was to identify bugs which are considered "interesting," therefore two different questions on interestingness were asked to improve validity across images and participants. Both fear and disgust are common emotional responses elicited by bugs (Breuer et al., 2015; Prokop & Fancovicova, 2010). Therefore, one question measured the level of specific harm the bug posed to the participant, while another question measured willingness to hold the bug as an indirect measure of fear and disgust. A measure of the relative attractiveness of the bug was used to include a measure of a positive emotional response, as some bugs were called as ‘pretty‘ and ‘cute‘ in Study 2. Lastly, a measure of familiarity was used to validate findings of this study with prior studies.

All items used during the image presentation of the survey were ranked on either a 5 or 7 point Likert-type scale. The first question was ‘The animal above is’ with response categories of 1 for “Very interesting” to 7 for “Very uninteresting.” The second question was ‘How interested would you be in learning more about this animal’ with response categories of 1 for “Not at all interested” to 5 for “Extremely interested.” The third question was ‘The animal above is’ with response categories of 1 for “Very attractive” to 7 for “Very Unattractive.” The fourth question was ‘How much do you know about this animal’ with response categories of 1 for “Not at all familiar” to 5 for “Extremely familiar.” The fifth question was ‘In terms of your personal safety, this animal seems’ with response categories of 1 for “Very harmful” to 7 for “Very Not Harmful.” The final question was ‘Would you be willing to hold the animal above in your hand’ with response categories of 1 for “Not at all willing” to 5 for “Extremely willing.”

The second portion of the study consisted of scale metrics that were hypothesized to predict interest in different bug types. Because the locus of control scale and desire for modern comforts scale did not significantly predict familiarity with bugs, these items were not repeated in this study (see results for Study 1). New scales were used that included a 25 item disgust-sensitivity scale, a 17 item dominance and prestige scale, and a 10 item curiosity and exploration scale. Three questions concerning past experiences were asked, the first asked ‘Did you ever make an insect collection’ with response categories of “Yes - in college,” “Yes - in high school,” “Yes - in elementary school,” “Yes - outside of school,” and “Never have.” The second question asked ‘Did you ever take an entomology course’ with response categories of “Yes - in college,” “Yes - in high school,” and “Never have.” The third question asked respondents to ‘Please rate your level of interest in each of the following activities. Then please indicate approximately how many times you participated in the activity during the last 12 months’. Listed response activates included; “Mountain biking,” “Rock climbing,” “Backpacking or hiking,” “Canoeing or kayaking,” “Hunting,” “Watching birds at a feeder,” “Bird watching with binoculars away from home,” “Tent camping,” “Fishing,” “Golfing,” “Vegetable gardening,” “Flower gardening,” “Playing video games,” “Running or jogging,” “Reading non-fiction books,” and “Reading fiction books.” Basic demographic information consisted of age, gender, race, highest level of education, zip code, if the participant was a parent or guardian of a child under the age of 12, and 1 to 7 item question ‘Do you consider yourself to be an “Outdoorsy” person,’ with categories of 1 for “Definitely not” to 7 for “Definitely yes.”

Shipley and Bixler (2017) found evidence suggesting that disgust-sensitivity may predict overall interest in different bug types along with many other studies (Breuer et al., 2015; Prokop & Fancovicova, 2010). A disgust-sensitivity scale that assessed different levels of disgust-sensitivity along three subscales (Core disgust, animal reminder disgust, and contamination-based disgust) was used to further examine how disgust-sensitivity might predict interest in unfamiliar bug types. The disgust-sensitivity scale used was modified from a study by Olatunji et al. (2007). Thirteen of the items were scored along a “True” or “False” response category. Participants were asked ‘Do the following statements describe you? Please select true or false.' The remaining twelve items were asked with the question 'Please rate how disgusting you would find the following experiences.' In the original article, this question was scored along a 1 to 3 scale, with 1 for "Not" to 3 for "Extremely." However, the response categories for this study were expanded to a 1 to 5 scale to add variability to responses, with 1 for "Not," 3 for "Somewhat," and 5 for "Extremely." (See Appendix E for a complete list of scale items). The internal consistency of all 25 items of the disgust scale was acceptable (Cronbach's alpha = .85, mean inter-item correlation = .21) with acceptable internal consistencies for the core disgust and animal reminder disgust subscales, core disgust (Cronbach's alpha = .75, mean inter-item correlation = .23), animal reminder disgust (Cronbach's alpha = .77, mean inter-item correlation = .32), and contamination-based disgust (Cronbach's alpha = .55, mean inter-item correlation = .228). Factor scores for the scale and each subscale were calculated as the sum of the related items following the scoring procedure from Olatunji et al. (2007).

It was hypothesized that interest in bugs would be negatively related to high levels of desire for social status because bugs are typically viewed negatively and with distaste. To test the hypothesis, a dominance and prestige scale was used to measure the two forms of pride (social status): hubristic and authentic. Cheng et al. (2010) constructed a dominance and prestige scale to examine the role of hubristic and authentic pride in relation to the status-obtaining strategies of dominance and prestige and found that dominance was related with hubristic pride while prestige was related with authentic pride. The scale used by Cheng et al. (2010) consisted of 17 item scale. The scale had one question that asked the participant ‘How accurately does each sentence below describe you?’ Response categories were scored along a 1 to 7 Likert-type scale with 1 being “Not at all” and 7 being “Very much.” (See Appendix E for a complete list of scale items). Following the procedure from Cheng et al. (2010) a principle components analysis with a direct oblimin rotation was conducted to produce two factors (Table 3.4). All eight dominance items loaded onto the dominance factor (eigenvalue = 5.68, percentage variance = 33.39%, Cronbach’s alpha = .88, mean inter-item correlation = .49) and all nine prestige items loaded onto the prestige factor (eigenvalue = 3.66, percentage variance = 21.52%, Cronbach’s alpha = .87, mean inter-item correlation = .43). A regression score for each factor was calculated for each respondent.

Also hypothesized was that personality traits related to openness to new experiences, specifically curiosity, might predict individual interest in unfamiliar bug types. Kashdan et al. (2009) developed a psychologically validated 10-item inventory to assess curiosity and exploration. Five items were developed to measure motivation to seek out new experiences (stretching) and five items to measure willingness to embrace novel events (embracing). The 10-item inventory was measured on a 1 to 5 scale. The question asked the participant ‘How accurately do these statements describe the way you generally feel and behave’ with response categories of 1 for “Very slightly or not at all” to 5 for “Extremely.” (see Appendix E for a complete list of scale items). Following the procedure from Kashdan et al. (2009) a maximum-likelihood estimation with a promax rotation was conducted to produce two factors. All five exploration/stretching items loaded onto the stretching factor (eigenvalue = 5.36, percentage variance = 53.62%, Cronbach's alpha = .86, mean inter-item correlation = .52) and all five curiosity/embracing items loaded onto the embracing factor (eigenvalue = 1.51, percentage variance = 15.10%, Cronbach's alpha = .88, mean inter-item correlation = .59). A regression score for each factor was calculated for each respondent.

Procedure & Implementation. Data were collected online via Amazon's Mechanical Turk following IRB approval (IRB2016-348). The procedure followed the same ethical recommendations and eligibility criteria used in Study 1. (see Study 1 Procedure for a detailed review of using AMT as a survey sampling service).

The HIT for this study was titled "Reactions to images of wildlife (Survey no more than 25 minutes)." The description of the HIT was "We want to know your reactions to different animals!" The keywords for the HIT were "survey, animals, birds, reptiles, fish, critters, bugs, insects, knowledge, research, study, know, familiar, photo, fun, and fast." When respondents clicked the HIT, they were asked to follow an external hyperlink that directed them to an online survey that was conducted using Qualtrics. The Qualtrics survey consisted of two sections. The first section had participants view each of the 45 images individually. Images were randomly presented to the participant. There was no time limit but participants were encouraged to view the images quickly. The second section of the survey consisted of the scale items, experiences with bugs, and basic demographic information. Following completion of the survey, participants were presented a unique identifier code and directed back to the AMT HIT. Once back at the HIT, participants entered the unique identifier code which was subsequently used to ensure the participant had actually competed the survey. Upon initial review of the data to ensure the survey had been completed, participants were paid electronically through the AMT interface.

Analysis. Data were cleaned, organized, and analyzed using IBM SPSS statistics version 23. Factor analysis was conducted on scale response items. A k-means cluster analysis was conducted to group bugs according to fear, disgust, and attractiveness scores. ANOVA and linear regression were conducted to predict average grouping scores across clustered bug groups. Descriptive data were used to identify the most and least interesting bugs, and which ones were used in Study 4.

Study 4 – Attentional Traits of Bugs

Participants. A random sample of 400 students were sent an email through the Office of Institutional Research at Clemson University. Forty-two students who confirmed their willingness to take part in the research were selected to participate, with selection balanced for gender. An additional sample of students from the Clemson University Entomology Club were asked to participate (n=6). Students of the entomology club were used as a comparison group due to their high familiarity with insects. Because of the increased likelihood that entomology students would be more likely to recognize bugs used in the study, their data provided a unique comparison group for the primary student sample (n=42). Following the recommendations found in the literature, 48 students was selected as the ideal target sample size to meet adequate power recommendations needed for a within-subjects qualitative eye tracking procedure (Bojko, 2013; Faulkner, 2003). All participants (n=48) were compensated with a $20 Visa gift card for their participation in the study. The sample was slightly more male (60 % male) predominantly white (72%), and mostly graduate students (72%) with ages ranging from 20 to 52 (*M* = 28.39, *SD* = 6.48).

Data Instrument & Development. Study 4 consisted of four sections. The first, second, and third sections involved collecting measures of foveal gaze while participants viewed image stimuli. The fourth section collected self-report measures on a 25 item disgust-sensitivity scale and a 10 item Big-5 trait personality scale. Participants also reported if they had ever made an insect collection, had ever taken an entomology course, and listed age, gender, race, year in college, and major (see Appendix H for specific information regarding scale items and questions).

Stimuli displayed in this study were the same image stimulus used in the prior studies. Of the 42 bug images used in Study 3, 34 bug types were selected for this study. Image stimuli were selected by selecting the 17 bug types that had received the highest 'interestingness' scores in Study 3, while the remaining 17 bugs types were those that had been ranked with the lowest 'interestingness' scores (see results of Study 3 for a more thorough discussion on this selection process). All images used in this study were of the same orientation and layout that had been used in the prior studies (i.e., full color, faced to the left, centered on a white background).

The first eye tracking section had participants view a static image which resembled the inside of a natural history museum. The scene contained five large square images along the back wall of the museum (see Figure 3.2 for a depiction). The image was manipulated in Adobe Photoshop CC 2015 so that one of the images along the wall in the museum scene displayed a single bug type while another image displayed a tiger. The tiger was chosen given their visual appeal and recognition as a charismatic mega-fauna (Walpole & Leader-Williams, 2002). Two separate images were created, one using the most interesting bug type (saddleback caterpillar) while the other was made with the least interesting bug type (pill bug) (See Figure 3.2 for examples of both images). The presentation of each image was counter-balanced across all participants.

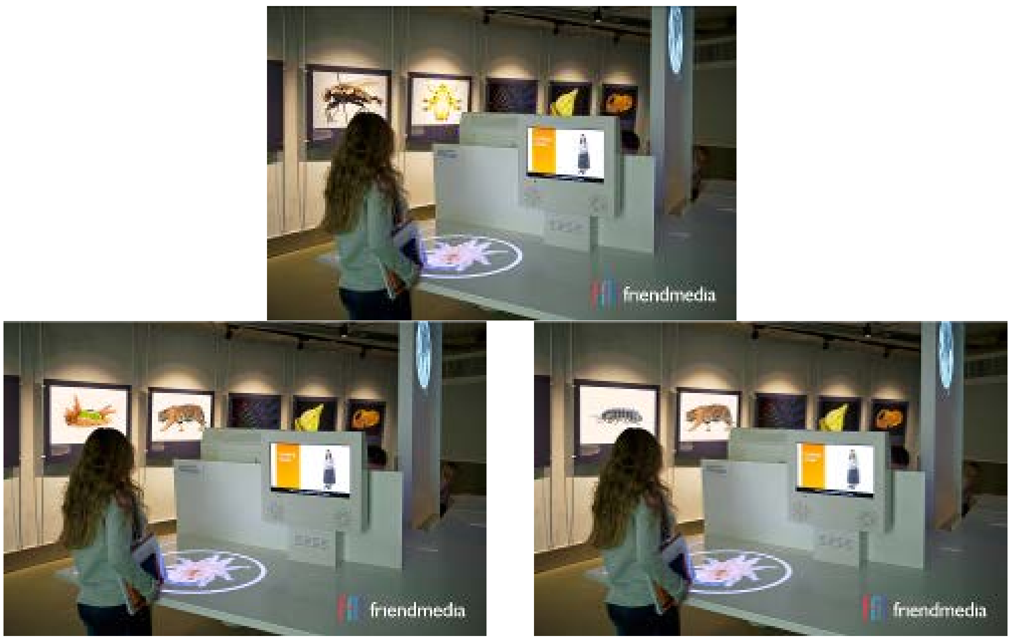

Figure 3.2. Images of museum used in Study 4. Bottom left is the 'interesting' saddleback caterpillar, while bottom right the 'uninteresting' pill bug.

The second eye tracking section of the study compared the 17 interesting bugs to the 17 uninteresting bugs. Images were paired side by side systematically such that each pair of images shown to the participant consisted of one interesting bugs and one uninteresting resulting in 17 possible images (see Figure 3.3 for an example). Image pairings were counterbalanced so every interesting bug would be compared with every uninteresting bug at least twice during the entire study across all participants. Additionally, all interesting bugs and uninteresting bugs were counterbalanced between the left and right side of the image pairings so that interesting or uninteresting bugs would not always appear on one side or the other of the paired images. During this section, participants were asked to view the images and report to the researcher which bug type (either the image displayed on the left or right) of each pair they would like to learn more about.

Figure 3.3. Image of side by side comparison. Would be shown to participants on the computer screen. On the left is the interesting bug (red-banded leafhopper - 71) and an uninteresting bug on the right (scorpion – 76).

The third eye tracking section had participants view each of the 34 bug types individually, rather than in pairs. Each image was shown randomly to participants. Participants were asked to view the images respond to four questions after viewing each image. The four questions were items used in Study 3. The questions were ranked on either a 5- or 7-point Likert-type scale. The first question was ‘The animal above is’ with response categories of “1” for “Very attractive” to “7” for “Very Unattractive.” The second question was ‘How interested would you be in learning more about this animal’ with response categories of 1 for “Not at all interested” to 5 for “Extremely interested.” The third question was ‘Would you be willing to hold the animal above in your hand’ with response categories of 1 for “Not at all willing” to 5 for “Extremely willing.” The fourth question was ‘In terms of your persona safety, this animal seems’ with response categories of 1 for “Very harmful” to 7 for “Very Not Harmful.” By having participants view each bug individually, specific target areas of interest (AOI) could be analyzed for each bug. Furthermore, by asking the four questions for each bug, data collected in this study could be compared with findings from Study 3.

The disgust-sensitivity scale used was modified from a study by Olatunji et al. (2007). Thirteen of the items were scored along a “True” or “False” response category. Participants were asked ‘Do the following statements describe you? Please select true or false.’ The remaining twelve items were asked with the question ‘Please rate how disgusting you would find the following experiences.’ In the original article, this question was scored along a 1 to 3 scale, with 1 for “Not” to 3 for “Extremely.” However, the response categories for this study were expanded to a 1 to 5 scale to add variability to responses, with 1 for “Not”, 3 for “Somewhat”, and 5 for “Extremely.” (see Appendix H for a complete list of scale items). Overall, the internal consistency of all 25 items of the disgust scale was acceptable (Cronbach’s alpha = .85, mean inter-item correlation = .20) with acceptable internal consistencies for the core disgust and animal reminder disgust subscales, core disgust (Cronbach’s alpha = .74, mean inter-item correlation = .22), animal reminder disgust (Cronbach’s alpha = .78, mean inter-item correlation = .32). However the internal consistent of the contamination-based disgust was low (Cronbach’s alpha = .54, mean inter-item correlation = .22). Factor scores for the scale and each subscale was calculated as the sum of the related items following the scoring procedure from Olatunji et al. (2007).

The Big-Five Inventory (BFI-10) personality scale was used from Rammstedt and John (2007). Personality was measured rather than dominance/prestige and curiosity/exploration to extend the findings of Study 3 and attempt to identify additional general individual differences that might predict interest in bugs. The 10 item scale was chosen over a more robust measure of personality, as examining personality traits was not the primary scope of this research. The authors of this personality scale state that research in which the primary scope is not personality traits is the ideal setting to implement a brief measure of personality. The scale consists of 10 items, with two questions measuring each domain of the Big-Five personality traits (i.e., openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism). The question asks participants 'How well do the following statements describe your personality', followed by 'I see myself as someone who…' Items are '… is reserved,' '…is generally trusting,' '…tends to be lazy,' '…is relaxed, handles stress well,' '…has few artistic interests,' '…is outgoing, sociable,' '…tends to find fault with others,' '…does a thorough job,' '…gets nervous easily,' and '…has an active imagination.' Response categories were rated on a 1 to 5 Likert-type scale, with 1 being "Disagree strongly" and 5 being "Agree strongly." Overall, the internal consistency of all 10 items of the scale was unacceptable as were each of the internal consistencies for the subscales. Therefore no additional factor measures were calculated using personality scores.

Procedure & Implementation. All stimuli were displayed on Dell UltraSharp U2412 M 24" LED monitor with 60Hz refresh rate. The screen resolution was set to 1680 x 1050 pixels. A Gaze Point GP3 pupil corneal reflection eye tracker was used with 0.5 – 1 degree of visual angle accuracy, 60 Hz sampling rate, 9-point calibration, with 25 cm of horizontal and 11 cm of vertical movement allowed, and with a ±15 cm range of depth movement. The tracker was calibrated using Gazepoint Control Software v3.1.0 and controlled by Gazepoint Analysis v3.1.0. The display was driven by a ASUSTek ROG751 JL laptop with an Intel Core I7-4720HQ 2.6GHz processor, 16GB (4x 4GB) 1600 MHz DDR3L RAM, a 512GB Samsung SSD 850 Pro hard drive, and a nVIDIA GeForce GTX 965M 2BG GDDR5 video card.

The study was conducted following IRB approval (IRB2017-009). Participants were first contacted via an email that was sent to a randomized sample of 400 students. Overall 66 students responded to the original email. Participants were first screened for abnormal vision by asking participants if they wore glasses or contacts and if they have any other abnormal vision characteristics. Due to the limitations imposed by the eye tracking devices, participants who wore glasses and could not see without corrective lenses or participants with abnormal vision were unable to participate (n = 6). Once recruited, participants were scheduled for a day and time to arrive at the eye tracking lab to conduct the experiment. Data were collected in an advanced computer lab that was designed for minimized distractions, fitted with comfortable chairs and fluorescent light bulbs that emitted a moderate brightness. Upon arrival to the lab, participants were greeted by the researcher and given a letter of informed consent to authorize their participation. Participants were asked if they had any questions.

The experiment began with the participants being seated in front of a computer monitor. Height of the chair and distance of the chair from the computer monitor was adjusted for each participant. Following chair adjustments, participants were instructed to look at the computer monitor and follow a nine-point dot calibration with their eyes. The testing procedure took part in three sections. Participants were given instructions prior to starting each section (see Appendix I for procedural instructions given to participants). Every participant started the experiment by viewing the first eye tracking section. Afterwards, they completed either the second or third eye tracking sections. The second and third eye tracking sections were counterbalanced between participants. Upon completing the second or third eye tracking section (which ever was second following the museum image), respondents completed the survey portion of the research, then concluding the experiment by taking the other eye tracking portion of the study. (See Figure 3.4 for a depiction of the procedural design).

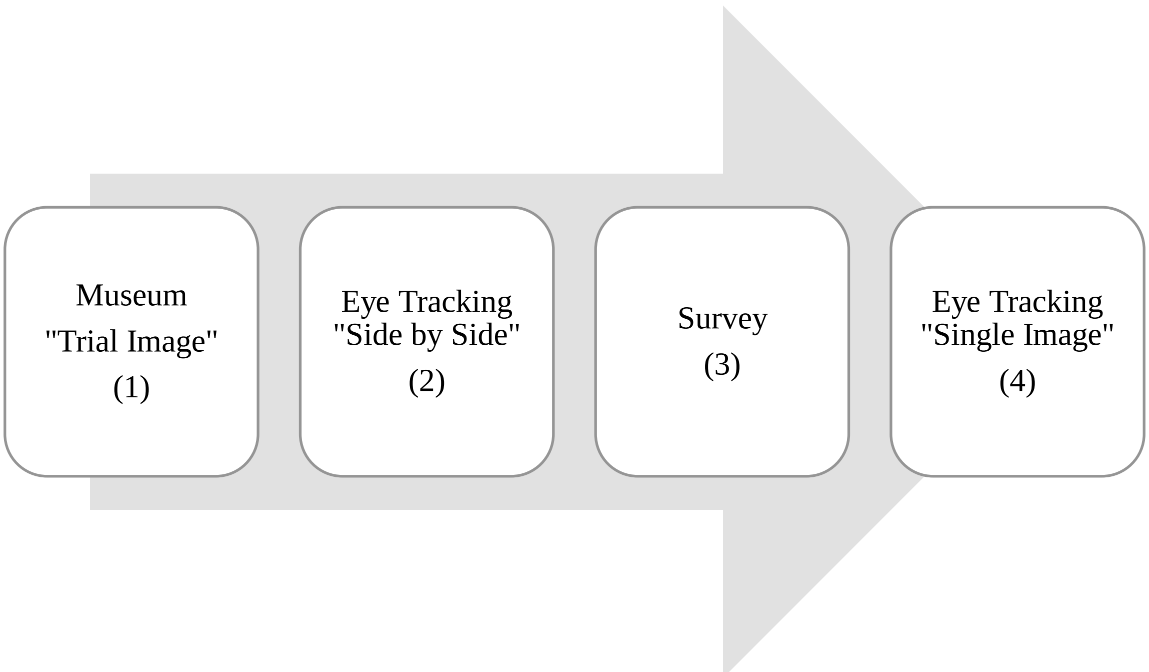

Figure 3.4. Flow of Study 4. Step 2 and step 4 were counterbalanced between every other particpant.

During the first eye tracking study, participants viewed the static museum image. The image was shown for ten seconds following the presentation of a single crosshair to focus the participant's attention to the screen. Participants were instructed to view the image naturally, as if they were looking at an image in a magazine. They were provided no additional instructions. After viewing the image, the study was concluded and the researcher began the following study.

During the second eye tracking section, participants were instructed to gaze forward at the monitor. The first image was a blank image that initiated the procedure upon pressing the 'spacebar'. Upon pressing the spacebar, the software displayed a single crosshair for 1000 milliseconds in the center of the screen to focus the participant's attention to the middle of the screen (Hout & Goldinger, 2015). Following the crosshair, a paired bug image was displayed on the screen for 5 seconds, allowing the participant to sufficiently view each image and evaluate subjective preference (Dixson, Grimshaw, Ormsby, & Dixson, 2014; Nummenmaa, Hietanen, Santtila, & Hyona, 2012). After the five second display time, the software displayed an all-white image, during which time the participant verbally indicated to the researcher which of the two bugs they would like to learn more about. This cycle was repeated for all 17 possible trials. During image viewing, participants were previously instructed to view the images naturally as if they were reading a magazine (Nummenmaa, Hietanen, Santtila, & Hyona, 2012).

After completion of the second section, participants were given a few minutes to complete the survey that consisted of the scale items and demographic information. This was done intentionally as both the first and second eye-tracking portions of the study used identical images. Rather than having participants complete the survey at the end of the experiment, the survey was conducted in between the second and third eye-tracking sections to temporally separate each section.

The final section of the study was the third eye-tracking portion of the study. This section was similar to the first section procedurally, each image was preceded by a crosshair that was displayed for 1000 milliseconds, the individual bug image was displayed for 5 seconds, followed by the four scale response items. These four scale questions (attractiveness, interest in learning, harmfulness, and willingness to hold in hand) were displayed indefinitely to give the participant the necessary time required to respond. Following a verbal response for each time, the researcher pressed the spacebar to initiate the next crosshair and subsequent image. This trial procedure was repeated 34 times, so that each bug image was shown to the participants. All images were randomized to reduce ordering biases. Following completion of the final section, participants were de-briefed and thanked for participation. They then filled out a form indicating they had received their incentive for participating. Participants were able to leave after receiving their incentive.

Data Analysis. Typically, data produced from an eye tracker is noisy. Filters are commonly applied to gaze data in order to smooth the data (Duckowski, Babu, Bertrand, & Krejtz, 2014; Nyström & Holmqvist, 2010). Furthermore, there are multiple types of algorithms used to identify and differentiate between visual fixations and saccades (Salvucci & Goldberg, 2000). Following recommendations from Ouzts and Duckowski (2012), a velocity-based differential algorithm was used to identify visual fixations. Fixations were classified using a third-order Savitzky-Golay (SG) (Savitzky & Golay, 1964) differential filter with width 5 to smooth gaze points at a sampling rate of 60Hz. The velocity threshold for the SG filter was set to 5°/s in order to maximize the number of fixations identified. The data was then cleaned following Bojko, 2013. Data analysis for the first eye tracking study involved setting AOI parameters around the left and right side of each bug pair image. Data analysis using AOIs produced number of fixations, total fixation duration, longest fixation, time to first fixation, and duration of first fixation for each bug image. For the second eye tracking section, AOI parameters were set for each bug so that an AOI was set around the head of the bug, the body of the bug, the legs of the bug, and around any unique appendage the bug might display (e.g., large fangs, horns, claws, etc.). Data collected included number of fixations, total fixation duration, time to first fixation, and first fixation duration for each AOI for every bug. By using fixation and duration data, it is possible to determine the participant's mode of information processing. If fixations are short followed by fast saccades, it is likely the participant is viewing the static image under an ambient mode of visual processing. In contrast, if fixations are long with short saccades, then it is likely that the image is being processed through the focal mode of visual processing (Velichkovsky et al., 2005). Therefore, by identifying long fixations, it is possible to determine what traits of bugs capture focal attention. In addition, the data analysis produced a series of gaze/scan plots and heat maps, which were used to better understand what traits of bugs received the most attention.

Additional data analysis involved determining if visual gaze patterns differ between persons based on reported individual differences. Reported disgust-sensitivity measures, personality measures, and levels of expertise with insects were used to detect any individual differences in gaze patterns. Reported scale items to individual bugs in the second eye tracking section were used to compare data from this sample with data collected in Study 3.

Summary

A series of four integrated and successive studies sought to address six principle research questions. The first study examined what types of bugs are most and least recognized by the general public. Findings from the first study suggest that studying bugs which are generally unknown might be most productive at an applied level. The second and third study examined subjective perceptions of unknown bugs. The second study examined perceptions under a qualitative paradigm while the third study examined perceptions systematically through a series of quantitative subjective questions. The final study examined visual attention of bugs to begin to understand what traits of bugs catch people's visual attention. Taken together, these studies explored people's first impressions of unknown bugs by determining what traits are most looked at. Conclusions will be based on the assumption that traits of bugs most viewed are likely the traits responsible for eliciting the emotional responses given in the subjective responses. The next chapter presents a detailed discussion on the results of each study and begins to answer each studies' relevant research question(s).

CHAPTER IV

RESULTS

Overview

This chapter summarizes research results from each of the four studies. For each study, descriptive results are first presented, followed by results for each relevant research question. Results from Study 1 identify which bugs are familiar and unfamiliar, addressing research question #1 and #2. The second study presents a qualitative analysis of subjective emotional responses elicited by images of unfamiliar bugs. The third study presented the same images used in Study 2 but asked respondents to rate the images based on "interestingness," "interesting in learning," "attractiveness," "harmfulness," and "willingness to hold." Both Study 2 and 3 address research questions #3 and #4. The fourth and final study presents gaze data on interesting and non-interesting bugs, identifying traits of bugs that capture visual attention. Results from Study 4 are used to answer research question #5 and #6. Findings are summarized at the end of the chapter.

Study 1 – Unknown Bugs

Descriptive Results. Mean familiarity scores were calculated for all 100 bug and distractor animals. The highest possible score for both the "familiarity" and "seen it" scores was 5. The five bugs with the highest mean "familiarity scores" were: ladybug (48), monarch butterfly (57), earthworm (23), European honey bee (26), and house cricket (42) (M = 4.73, SD = .62; M = 4.69, SD = .54; M = 4.28, SD = 1.03; M = 3.93, SD = 1.14; M = 3.92, SD = 1.24, respectively). The five bugs with the lowest mean familiarity score were: the peanut-headed moth (64), monkey slug caterpillar (59), scorpionfly (77), antlion (1), and the hairy beetle (35) (M = 1.01, SD = .15; M = 1.04, SD = .26; M = 1.06, SD = .32; M = 1.08, SD = .45; M = 1.09, SD = .44, respectively). (See Figure 4.1 for pictures of the five most and least familiar bugs). The five bugs with the highest and lowest mean "seen it" scores were the same as the familiarity scores.

Figure 4.1. Most familiar bugs. From top left to right; ladybug, monarch butterfly, earthworm, honey bee, house cricket. Least familiar bugs, from bottom left to right; peanut-headed moth, monkey slug caterpillar, scorpionfly, antlion, and hairy beetle

Bug names listed by participants were scored either as a 0 or a 1. A 0 indicated that either the participant did not enter a name for the bug or did not correctly identify the bug type. A correct answer was scored as a 1. Answers were scored as correct if the participant had identified the bug at a generic level (e.g., jumping spider was scored as correct even if the participant had just listed "spider"). Monarch butterfly (57) received the most correct identifications, followed by the ladybug (48), earthworm (23), scorpion (76), and European honey bee (26) (percent correct: 99.1%, 97.2%, 93.5%, 87.0%, and 86.6% respectively). Interestingly, the house cricket (42) (which had received high familiarity and see scores), only was identified correctly by 55% of the participants. Of the participants who listed a name for the house cricket, 62 people (28.7%), identified the cricket a grasshopper. Of the 99.1% of participants who correctly identified the monarch butterfly, 90 participants (41.6%), identified the butterfly explicitly as a "monarch butterfly". Four bug types were only correctly identified by two participants: Two-striped planthopper (94), the red-banded leafhopper (71), milkweed bug (54), and the mantidfly (53). Additionally, seven bug types were not correctly identified by any of the participants: dragonfly larva (21), longhorn beetle (50), peanut-headed moth (64), fly (bee mimic) (30), plant bug (68), dobsonfly (18), and cactus bug (5). (See Figure 4.2 for images of the incorrectly identified bugs)

Figure 4.2. Incorrectly identified bugs. From left to right, top row; red-banded leafhopper, two-striped plant hopper, milkweed bug, mantidfly. Middle row; dragonfly larva, longhorn beetle, peanut-headed moth, fly. Bottom row; plant bug, dobsonfly, cactus bug.

Research Question #1. The focus of Study 1 was to establish levels of familiarity people had with 90 bugs. To understand the levels of familiarity with bugs, a k-means cluster analysis was conducted using mean familiarity scores for each bug and did not include “seen it” scores, because of a significant Spearman’s rho rank correlation (r = .99**) between familiarity and seen it scores. To sufficiently explore empirical potential clusters of bug familiarity, a four cluster, a five cluster, and a six cluster solutions were examined. A hierarchical linear regression predicting mean familiarity scores was conducted using the four, five, and six cluster solutions as predictor variables. This was done to examine the amount of unique variance that each clustering solution would explain. Table 4.1 displays the model summary. The multiple R^2 change from the four cluster method to the five cluster method explained an additional five percent of the variance, while the change from a five cluster solution to a six cluster solution only explained an additional 1.5 percent. While the model change due to the six cluster solution was significant, it was determined that a five cluster grouping was optimal as it provided a significant increase in variance explained over a four cluster solution. Additionally, a five cluster solution is more parsimonious than a six cluster solution and is easier to interpret. The five cluster groups were named “Well Known,” “Known,” “Familiar,” “Unfamiliar,” and “Unknown” in order of highest mean familiarity scores to the lowest (see Table 4.2 for mean cluster scores and names). The five cluster solution was used to group bugs and then calculate participants mean familiarity score for each bug cluster. Mean cluster familiarity scores were used in subsequent analysis to examine research question #2.

Table 4.1

Model summary of the 4, 5, and 6 cluster solution predicting familiarity scores

Model			Change Statistics		
	R	R Square	R Square Change	F Change	Sig. F Change
1	.953[a]	.908	.908	871.631	.000
2	.980[b]	.960	.051	110.992	.000
3	.987[c]	.974	.015	48.945	.000

a. Includes the 4 cluster solution
b. Includes the 4 and 5 cluster solution
c. Includes the 4, 5, and 6 cluster solution

Table 4.2

Average familiarity scores of the five familiarity clusters

Well Known		Known		Familiar		Unfamiliar		Unknown	
Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
4.71	0.47	3.73	0.78	2.87	0.78	1.87	0.59	1.23	0.29

Note. Measured on a 1-5 scale, with 5 being "Extremely Familiar"

Some respondents reported familiarity with some bugs but gave an incorrect identification for some bug types. While correct identification scores were not used to cluster bugs into groups that guided the subsequent studies, some notable relationships between familiarity scores and identification were found. A Spearman's rho correlation (r = .82**) between familiarity and correct identification was found, suggesting that both constructs were related. However, the relationship between familiarity and identification was not as strong as familiarity scores were with see scores. The rank correlation was lower due to cases where bugs score high on familiarity were incorrectly identified by participants. Using the five-bug cluster familiarity based grouping, a histogram was created to visualize aberrant bug scores. Figure 4.3 displays that case items 11, 24, 26, and 28 are extreme cases where familiarity scores (used in the clustering method) differed from correct identification scores. At first glance, the extreme cases suggested a need to revisit the five cluster solution of bug familiarity. Each extreme case was examined individually to ascertain the need to regroup the bug scores. Item 11 was the damselfly (17), this bug is superficially similar to a dragonfly and it was evident based on identification scores that participants had believed the damselfly was a dragonfly (167 participants listed “dragonfly”). Item 24 was the jumping spider (44). Differences between familiarity and identification scores for the jumping spider likely arose from the scoring procedure, specifically, 180 participants (83.3%) had listed a response in relation to a spider (e.g., “jumping spider,” “spider,” “wolf spider,” or “tarantula”). However, 91 respondents (42.1%) specifically identified the jumping spider as a “tarantula.” Item 26 was the crane fly (16), which is superficially similar to a mosquito. Differences between familiarity and identification for the crane fly likely arose from many participants incorrectly identifying the bug as a mosquito (43.9%). The last extreme case, item 28, was a fly (30) that displays color patterns (mimicry) similar to a bee or wasp (i.e., black and yellow coloration). No respondents correctly identified it. Given that the four extreme cases were due to misidentifications of superficially similar bugs, it was determined that familiarity scores still provided a robust measure on which to disaggregate bugs into groups based on overall familiarity and recognition of bug types. (See Figure 4.4 for images of the four extreme case bugs).

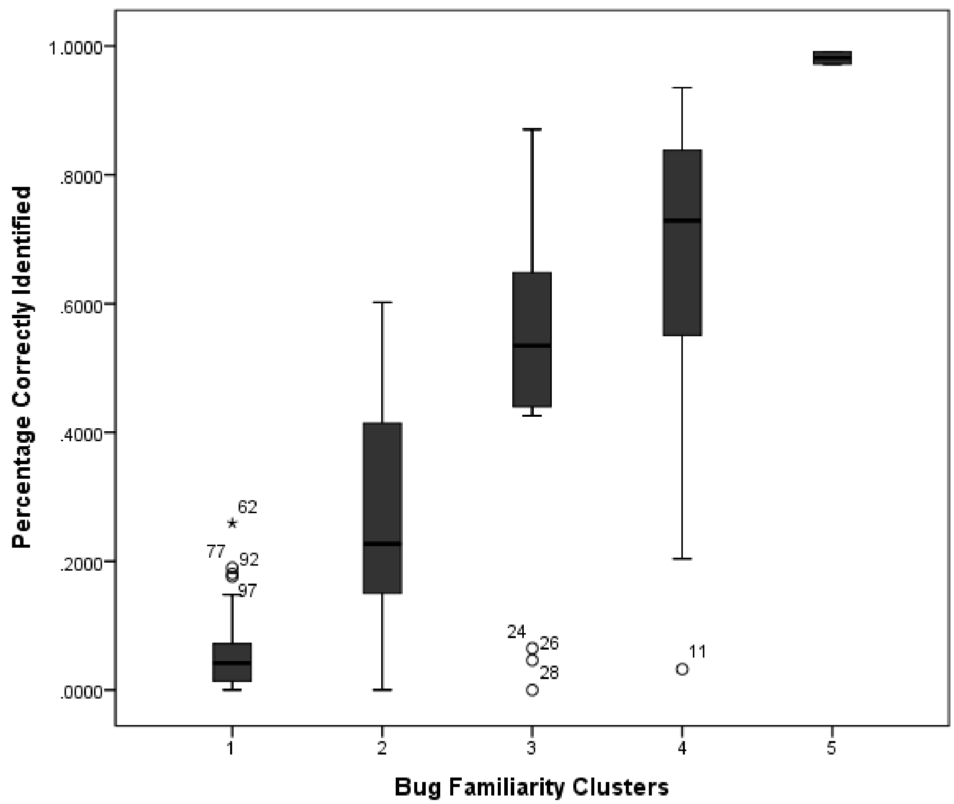

Figure 4.3 Histogram of correct identification bug scores. Distributed along the bug familiarity clusters. For example, bug 11 was clustered in cluster 4 but was incorrectly identified.

Figure 4.4. Bugs that participants assigned high familiarity scores but incorrectly identified. Clockwise from top left; damselfly, jumping spider, crane fly, fly (bee mimic).

Research Question #2. A desire for modern comfort scale was used to operationalize sensitivity to disgust and used as a predictor of familiarity with bugs. Responses to the desire for modern comforts scale indicated that a majority of the participants would miss modern conveniences related to hygiene, such as running water and showering (measured on a 1 to 5 scale with 5 being "Can't live without" items were $M = 3.89$, $SD = .98$ and $M = 3.75$, $SD = 1.04$, respectively). But a lower desire for modern technological conveniences, such as television and telephone was indicated ($M = 2.51$, $SD = 1.22$ and $M = 2.61$, $SD = 1.27$, respectively). See Table C.2 for a mean ranked list of all scale items. There were no significant relationships between locus of control and any dependent variables, therefore locus of control was not used in subsequent analysis.

Using the five bug familiarity cluster solution, mean group bug familiarity scores were calculated for each participant. Mean scores for each familiarity cluster was treated as a dependent variable. Analytics were performed on each cluster to examine how individual differences between participants explained differences in familiarity with different bugs clusters.

Initial analysis was conducted using Pearson's product-moment correlations between participant self-ratings of "outdoorsy-ness" and mean familiarity scores between clusters. Because of the bimodal distribution along reported level of "outdoorsy-ness", the 7 item scale was clustered into a low, medium, and high level of "outdoorsy-ness" to create somewhat equal sized groups. The most significant relationship for "outdoorsy-ness" were between mean familiarity scores for the second, third, fourth, and fifth bug clusters ($r = .24^{**}$, $r = .29^{**}$, $r = .36^{**}$, and $r = .23^{**}$, respectively).

A repeated measures analysis of variance (RM-ANOVA) was conducted to examine the effects that reported levels "outdoorsy-ness" had on predicting participant mean familiarity scores between the five bug familiarity clusters. Four overly influential cases were removed from the model. Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated ($X^2_{(9)} = 246.26$, $p < .001$), therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .67$). With a Greenhouse-Geisser correction, there was a significant difference for the main effect of familiarity clusters on overall familiarity scores ($F_{(2.63, 527.57)} = 2356.64$, $p < .001$, $r^2 = .92$). The main effect of "outdoorsy-ness" on familiarity scores was statistically significant ($F_{(2, 201)} = 12.09$, $p < .001$, $r^2 = .11$). The interaction of "outdoorsy-ness" with familiarity clusters was also statistically significantly between familiarity scores ($F_{(5.38, 527.57)} = 65.38$, $p < 001$, $r^2 = .004$). Pairwise comparisons of familiarity scores between the main effect of bug clusters was statistically significant between all five clusters ($p < .001$ for all clusters). A test of main effects for "outdoorsy-ness" revealed that low and medium outdoor levels were not significantly different, however high outdoor scores were significantly different from both low and medium scores ($p < .001$ and $p = .004$, respectively).

To test the interaction between bug clusters and levels of "outdoorsy-ness," an ANOVA was conducted using the least significant difference (LSD) post-hoc method. The ANOVA revealed that familiarity levels were significantly different between outdoor levels for bugs in the second, third, fourth, and fifth familiarity clusters ($F_{(2,204)} = 6.107$, $p = .003$, $r^2 = .057$; $F_{(2,204)} = 7.819$, $p = .001$, $r^2 = .072$; $F_{(2,204)} = 14.677$, $p < .001$, $r^2 = .127$, and $F_{(2,204)} = 7.739$, $p = .001$, $r^2 = .07$, respectively). There was not a significant difference between familiarity levels between outdoor levels for bugs in the first familiarity cluster. The strongest relationship between outdoor levels and familiarity with bugs was in the fourth cluster, or the unfamiliar bugs, with an explained variance of 12.7%. Low, medium, and high levels of "outdoorsy-ness" were significantly different from each other along familiarity scores for the fourth "Unfamiliar" bug cluster. Figure 4.5 displays mean familiarity scores along outdoor levels with separate lines for each familiarity cluster. It is clear that familiarity scores are high for all outdoor levels for Well Known bugs, but as bugs become less familiar, higher levels of "outdoorsy-ness" become associated with higher familiarity scores across Known, Familiar, Unfamiliar, and the Unknown bug familiarity clusters.

There were no significant differences between age, gender, desire for modern comforts, or reported past experiences with bugs that predicated familiarity scores between the five bug familiarity clusters.

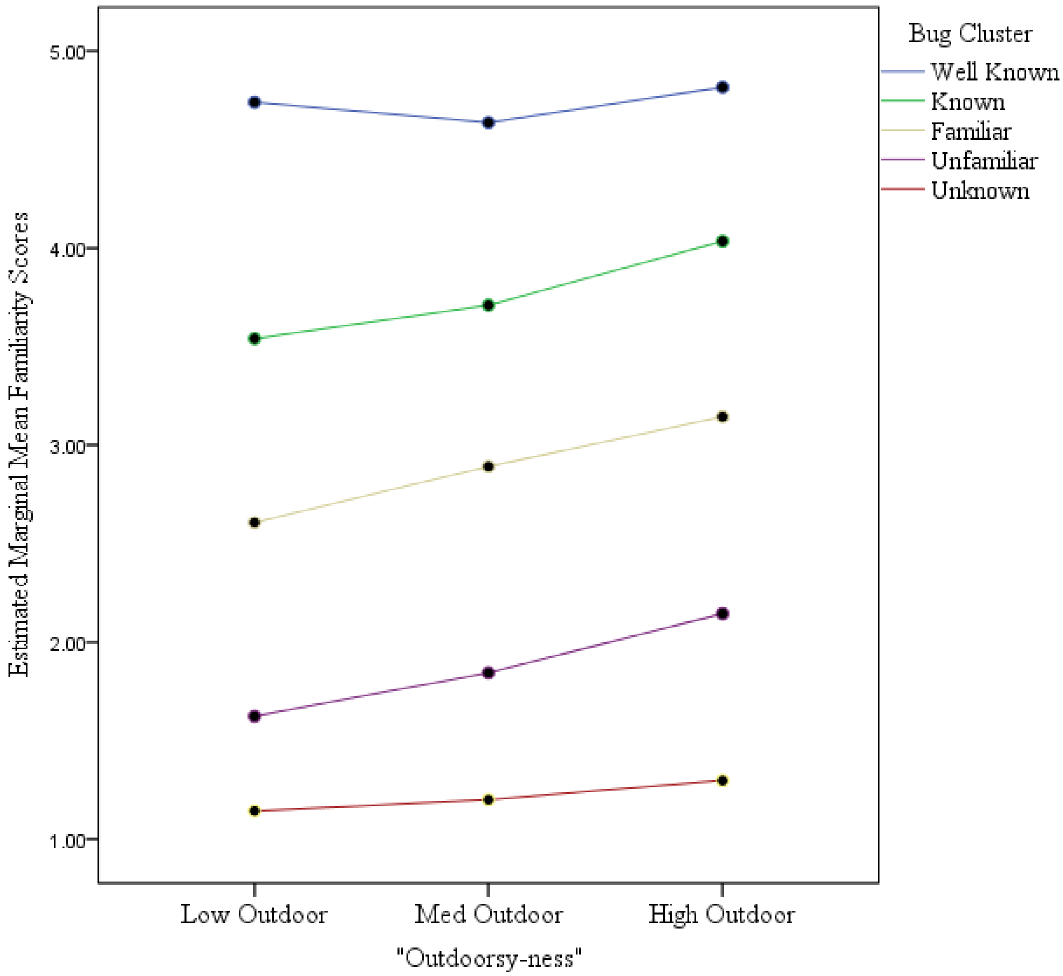

*Figure 4.5. M*ost people are familiar with Well Known bugs. People who are “outdoorsy” are more familiar with Unfamiliar bugs than people who are less “outdoorsy”

Study 2 – Perceptions of Bugs: Interviews

Descriptive Results. Of the 45 bug types shown to participants in the form of photographs, the most commonly used descriptive term was based on color. Table D.1 in Appendix D displays the 15 most commonly described traits of bugs that participants reported. Overall, participants described color at least once as a trait that stood out for 31 of the 45 bug types. Of the fifteen participants, twelve described "color" as the unique trait for the milkweed bug (54), with nine participants describing the shiny flea beetle (80) by its color, eight for the emerald ash borer (25), and seven for the red-banded leafhopper (71). Some example descriptions for color include participants reporting "pretty color," "orange coloration," "weird color," and "interesting color."

Aside from color, the most common descriptions were made about the physical traits of the bugs, for example "eyes," "wings," and the "head" of the bugs were most discussed. Other than describing physical morphological traits, participants also described bugs with basic subjective feelings. For instance, bugs were often described as "cool," "pretty," and "dangerous." Detail about the frequency and example of descriptive terms used to describe bugs can be found in Table D.1.

Study 2 was conducted to gather general first impressions about unfamiliar bugs. Images used in Study 2 were subsequently used in Study 3. The descriptive information gathered in Study 2 informed the questions asked about each bug in Study 3. Descriptive terms such as "color," "pretty," "dangerous," and "cute" informed decisions to include a question assessing the "attractiveness" and "harmfulness" of each bug.

Research Question #3. To help understand the visual perceptions of unfamiliar bugs, the most commonly used terms used by participants to describe each bug were analyzed. Table D.2 in Appendix D displays an alphabetical list of all bugs presented to participants in Study 2. For each bug, the most commonly used descriptive terms are presented along with the frequency. Overall, there appeared to be no discernable pattern of descriptions assigned to the different bug types. Additional analysis clustered bug types into familiar and unfamiliar bugs (based on findings from Study 1). However, even with this additional step, no pattern could be identified that was useful in systematically describing bug features associated with interestingness.

Study 3 – Perceptions of Bugs: Scales

Descriptive Results. Focus of the study was on unfamiliar bugs and identifying the different types of bugs perceived as interesting. Mean values for 'familiarity,' 'attractiveness,' 'harmfulness,' 'willingness to hold in hand,' 'interestingness,' and 'interested in learning more' scores were calculated for all 45 bug and distractor animals. The highest possible score for 'interestingness' scores was a 7, for "very uninteresting." The response categories for 'interestingness' were recoded so that 7 was "very interesting." The five bugs with the highest mean 'interestingness' scores were: saddleback caterpillar (74), monkey slug caterpillar (59), red-banded leafhopper (71), two-striped planthopper (94), and weevil (99) (M = 5.91, SD = 1.37; M = 5.84, SD = 1.37; M = 5.66, SD = 1.31; M = 5.36, SD = 1.42; M = 5.33, SD = 1.60, respectively). The five bugs with the lowest mean 'interestingness' scores were: pill bug (67), robber fly

(73), earwig (24), giant water bug (33), and spider (84) (*M* = 3.99, *SD* = 1.75; *M* = 4.04, *SD* = 1.68; *M* = 4.04, *SD* = 1.45; *M* = 4.24, *SD* = 1.73; *M* = 4.25, *SD* = 1.91, respectively). (See Figure 4.5 for images of bugs ranked highest and lowest on ‘interestingness’).

Figure 4.6. Most and least interesting bugs. From left to right, most interesting, top row; saddleback caterpillar, monkey slug caterpillar, red-banded leafhopper, two-striped planthopper, and weevil. Least interesting, bottom row; pill bug, robber fly, earwig, giant water bug, and spider.

The highest possible score for ‘interested in learning more’ scores was a 5, for “extremely interested.” Mean results were similar to mean scores for ‘interestingness.`’ The five bugs with the highest mean ‘interested in learning more’ scores were: saddleback caterpillar, monkey slug caterpillar (59), red-banded leafhopper (71), weevil, and two-striped planthopper (94) (*M* = 3.40, *SD* = 1.32; *M* = 3.39, *SD* = 1.32; *M* = 3.18, *SD* = 1.26; *M* = 2.99, *SD* = 1.38; *M* = 2.92, *SD* = 1.60, respectively). The five bugs with the lowest mean ‘interested in learning more’ scores were: earwig (24), robber fly (73), spider (84), millipede (56), and pill bug (67) (*M* = 2.18, *SD* = 1.23; *M* = 2.20, *SD* = 1.91; *M* = 2.22, *SD* = 1.30; *M* = 2.22, *SD* = 1.22; *M* = 2.23, *SD* = 1.17, respectively). (See Figure 4.6 for images of bugs ranked highest and lowest on ‘interested in learning more’).

Figure 4.7. Bugs that participations are most and least interested in learning more about. From left to right, most interested, top row; saddleback caterpillar, monkey slug caterpillar, red-banded leafhopper, weevil, and two-striped planthopper. Least interested, bottom row; earwig, robber fly, spider, millipede, and pill bug.

The highest possible score for 'familiarity' scores was a 5, for "extremely familiar." The five bugs with the highest mean 'familiarity' scores were: scorpion (76), butterfly (4), praying mantis (69), fly (bee mimic) (30), spider (84) (*M* = 3.03, *SD* = 1.27; *M* = 2.92, *SD* = 1.24; *M* = 2.88, *SD* = 1.23; *M* = 2.66, *SD* = 1.24; *M* = 2.44, *SD* = 1.21, respectively). The five bugs with the lowest mean 'familiarity' scores were: antlion (1), monkey slug caterpillar (59), weevil (99), saddleback caterpillar (74), and the tailless whip scorpion (87) (*M* = 1.15, *SD* = 0.58; *M* = 1.17, *SD* = 0.55; *M* = 1.18, *SD* = 0.52; *M* = 1.23, *SD* = 0.68; *M* = 1.24, *SD* = 0.64, respectively). (See Figure 4.7 for images of bugs ranked highest and lowest on 'familiarity').

Figure 4.8. Most and least familiar bugs. From left to right, most familiar, top row; scorpion, butterfly, praying mantis, fly, and spider. Least familiar, bottom row; antlion, monkey slug caterpillar, weevil, saddleback caterpillar, and tailless whip scorpion.

The 'attractiveness' scale used a high score of 7 as "very unattractive." The response categories for 'attractiveness' were recoded so that 7 was "very attractive." The five bugs with the highest mean 'attractiveness' scores were: red-banded leafhopper (71), butterfly (4), two-striped planthopper (94), katydid (45), tiger beetle (90) (*M* = 546, *SD* = 1.44; *M* = 5.30, *SD* = 1.37; *M* = 4.86, *SD* = 1.39; *M* = 4.83, *SD* = 1.50; *M* = 4.79, *SD* = 1.78, respectively). The five bugs with the lowest mean 'attractiveness' scores were: termite (88), giant water bug (33), spider (84), antlion (1), and earwig (24) (*M* = 1.79, *SD* = 1.25; *M* = 2.01, *SD* = 1.18; *M* = 2.15, *SD* = 1.53; *M* = 2.18, *SD* = 1.47; *M* = 2.27, *SD* = 1.32, respectively). (See Figure 4.8 for images of bugs ranked highest and lowest on 'attractiveness').

Figure 4.9. Most and least attractive bugs. From left to right, most attractive, top row; red-banded leafhopper, butterfly, two-striped planthopper, katydid, and tiger beetle. Least attractive, bottom row; termite, giant water bug, spider, antlion, and earwig.

The highest possible score for 'harmfulness' scores was a 7, for "very not harmful." The response categories for 'harmfulness' were recoded so that 7 was "very harmful." The five bugs with the highest mean 'harmfulness' scores were: scorpion (76), spider (84), fly (bee mimic) (30), pelecinid wasp (65), and spiny backed orb-weaver (85) (*M* = 6.35, *SD* = 0.92; *M* = 5.98, *SD* = 1.24; *M* = 5.64, *SD* = 1.15; *M* = 5.56, *SD* = 1.267; *M* = 5.43, *SD* = 1.38, respectively). The five bugs with the lowest mean 'harmfulness' scores were: butterfly (4), katydid (45), two-striped planthopper (94), red-banded leafhopper (71), and the emerald ash borer (25) (*M* = 1.79, *SD* = 1.24; *M* = 2.10, *SD* = 1.29; *M* = 2.36, *SD* = 1.25; *M* = 2.60, *SD* = 1.36; *M* = 2.72, *SD* = 1.30, respectively). (See Figure 4.9 for images of bugs ranked highest and lowest on 'harmfulness').

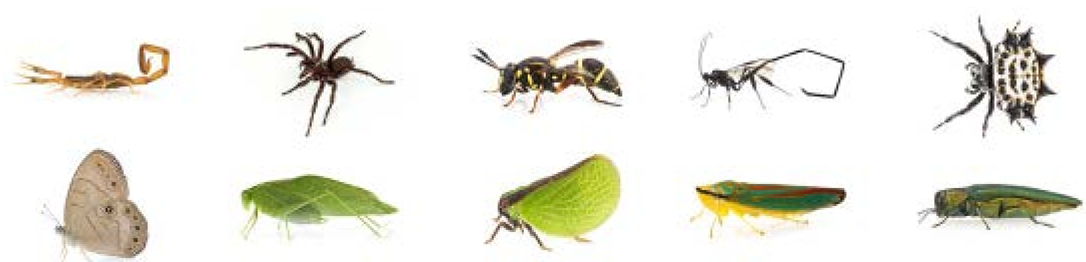

Figure 4.10. Most and least harmful bugs. From left to right, most harmful, top row; scorpion, spider, fly, pelecinid wasp, and orb-weaver. Least harmful, bottom row; butterfly, katydid, two-striped planthopper, red-banded leafhopper, and emerald ash borer.

The highest possible score for 'willingness to hold in hand' scores was a 5, with 5 being "extremely willing." The five bugs with the highest mean 'willingness to hold in hand' scores were: butterfly (4), katydid (45), praying mantis (69), two-striped planthopper (94), and the red-banded leafhopper (71) (*M* = 3.31, *SD* = 1.44; *M* = 2.74, *SD* = 1.37; *M* = 2.48, *SD* = 1.40; *M* = 2.44, *SD* = 1.33; *M* = 2.35, *SD* = 1.33, respectively).

The five bugs with the lowest mean 'willingness to hold in hand' scores were: scorpion (76), fly (bee mimic) (30), spider (84), pelecinid wasp (65), and mantidfly (53) (*M* = 1.24, *SD* = 0.62; *M* = 1.17, *SD* = 0.52; *M* = 1.18, *SD* = 0.59; *M* = 1.22, *SD* = 0.64; *M* = 1.24, *SD* = 0.62, respectively). (See Figure 4.10 for images of bugs ranked highest and lowest on 'willingness to hold in hand').

Figure 4.11. Bugs that participants are most and least willing to hold. From left to right, most willing, top row; butterfly, katydid, praying mantis, two-striped planthopper, and red-banded leafhopper. Least willing, bottom row; scorpion, fly, spider, pelecinid wasp, and mantidfly.

Composite scores from the disgust scale were normally distributed and ranged from 1 to 24, with a minimum possible score of 0 and maximum possible score of 25 (*M* = 12.99, *SD* = 4.77). Composite scores for the core disgust subscale ranged from 0.5 to 12, with a minimum possible score of 0 and maximum possible score of 12 (*M* = 6.84, *SD* = 2.49). Scores for the animal reminder disgust subscale ranged from 0 to 8, with a minimum possible score of 0 and maximum possible score of 8 (*M* = 4.19, *SD* = 2.12). Lastly, scores for the contamination subscale ranged from 0 to 5, with a minimum possible score of 0 and maximum possible score of 5 (*M* = 1.96, *SD* = 1.18). See Table F.2 in Appendix F for a mean ranked list of all scale items.

Mean response values for the curiosity/embracing subscale were lower than mean values for the stretching/exploration subscale ($M = 2.41$, $SD = 1.22$ and $M = 3.25$, $SD = 1.18$, respectively). See Table F.3 in Appendix F for mean ranked items for the curiosity and exploration scale. There was a bimodal distribution along the question assessing self-perceived level of being an "outdoorsy" person ($M = 3.84$, $SD = 1.94$, range of responses were 1 to 7), which was recoded into low, medium, and high levels of outdoorsy-ness. There were no significant relationships for the dominance and prestige scale and reported level of interest in different outdoor recreation and leisure activities.

Research Question #1 & 2. The intent of Study 3 was to identify interesting bugs, nonetheless this study provided data useful in validating findings from Study 1. Following the same k-means clustering procedure in Study 1, mean bug familiarity scores were used to form a five cluster solution. The cluster with the highest mean familiarity score contained one distractor item (Pikachu) and the second cluster contained four bugs (butterfly, fly mimic, praying mantis, and scorpion) and the remaining two distractor items (Charizard and Mewtwo). The remaining three clusters contained similar groupings as Study 1. A Pearson product-moment correlation of mean familiarity scores between bugs used in Study 3 and Study 1 was significant ($r = .92^{**}$), suggesting that familiarity scores between the two studies were similar.

To predict familiarity with bugs, mean values of familiarity were calculated for each cluster using bug type familiarity scores. Following the same analytic procedure in Study 1, "outdoorsy-ness" was the only independent variable that predicted mean bug cluster familiarity. Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated ($X^2_{(5)} = 288.54$, $p < .001$), therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .69$). With a Greenhouse-Geisser correction, there was a significant difference between bug familiarity clusters ($F_{(2.04, 597.50)} = 752.53$, $p < .001$, $r^2 = .71$). The main effect of “outdoorsy-ness” on familiarity scores was statistically significant ($F_{(2, 285)} = 7.60$, $p = .001$, $r^2 = .05$). The interaction of mean bug familiarity cluster scores and “outdoorsy-ness” was statistically significant ($F_{(4.08, 597.50)} = 5.59$, $p < .001$, $r^2 = .05$).

A pairwise comparisons of mean familiarity scores between the four bug clusters was statistically significant between all clusters ($p < .001$ for all clusters). A test of main effects for “outdoorsy-ness” revealed that low and medium outdoor levels were not significantly different, however high outdoor scores were significantly different from low scores on overall familiarity scores ($p < .001$).

Research Question #3. Study 3 determined what bugs were interesting and then identified different types of interesting bugs. After excluding familiar bugs, there appeared to be a difference is the distribution of interesting bugs across “attractiveness” and “harmfulness” scores. Because of the distribution of interesting bugs across attractivness and harmfulness scores, a principle components factor analysis with varimax rotation was conducted using grand mean ‘attractiveness’, ‘interestingness’, ‘willingness to learn more about’, ‘harmfulness’, and ‘willingness to hold in hand’ scores for each bug type. The analysis resulted in two factors. ‘Interestingness’ and ‘willingness to learn more about’ scores loaded onto a factor (INT) (eigenvalue = 2.36, percentage variance = 47.16%, Cronbach’s alpha = 0.73, mean inter-item correlation = .72).

‘Harmfulness’ and ‘willingness to hold in hand’ scores loaded onto another factor (HARM, note that harmfulness was negatively related to the factor) (eigenvalue = 2.26, percentage variance = 45.27%, Cronbach’s alpha = .77 mean inter-item correlation = .68). Attractiveness scores cross loaded onto the INT and HARM factor, however the variable was not removed from the analysis in order to best understand the overall effect of bug attractiveness on interest in bugs. A regression score for each factor was calculated for each bug type.

To group different types of interesting bugs, a k-means cluster analysis was conducted using both factor scores as grouping variables. An eight-cluster solution was found to predict the most variance between the interestingness factor and harm/hand factor ($r^2 = .92$ and $r^2 = .89$, respectively). See Figure 4.11 for a graphical depiction of the cluster solutions. There were two bugs clustered in cluster one, the saddleback caterpillar and monkey slug caterpillar (59), both of which had the highest INT factor scores but had fairly low HARM factor scores, suggesting that both bugs are perceived as potentially dangerous or harmful. There was only one bug in the third cluster, the red-banded leafhopper (71). This bug had high scores for both factors, suggesting it was generally perceived as pretty and harmless. Similarly, there were two bugs in cluster eight, the two-striped planthopper (94) and katydid (45), which are likely similar to the red-banded leafhopper (71) however are slightly less interesting. Three bugs were clustered into the fifth cluster, the millipede (56), pill bug (67), and eyed click-beetle (27). These bugs were the lowest bugs on the INT factor but high on the HARM factor suggesting these bugs were perceived as boring but not dangerous. Clusters four, six, seven, and two had similar scores along both factors. Cluster seven had high INT and HARM scores and contained bugs that were colorful and attractive, such as the tiger beetle (90) and milkweed bug (54). Bugs in cluster four were also rated high on HARM bug low on INT. Cluster four contained bugs such as the shiny flea beetle (80) and plant bug, which are also colorful but not perceived as interesting. Bugs in cluster two were rated high on INT but low on HARM. Cluster two contained the ichneumon wasp (32), scorpionfly (77), mantidfly (53), and pelecinid wasp (65). All four of these bugs are characterized with a morphological characteristic that is likely perceived as dangerous (scorpion-like tail, large tail that looks like a stinger, etc). In contrast, bugs in cluster six and perceived as equally harmful as bugs in cluster two, however were scored lower on the INT factor. Many bugs in cluster six, such as the earwig (24) and assassin bug (2), are characterized as having traits that are also likely perceived as dangerous, such as pincers. It is likely that bugs in cluster two have traits that are likely perceived as dangerous, but are also novel and therefore perceived as interesting.

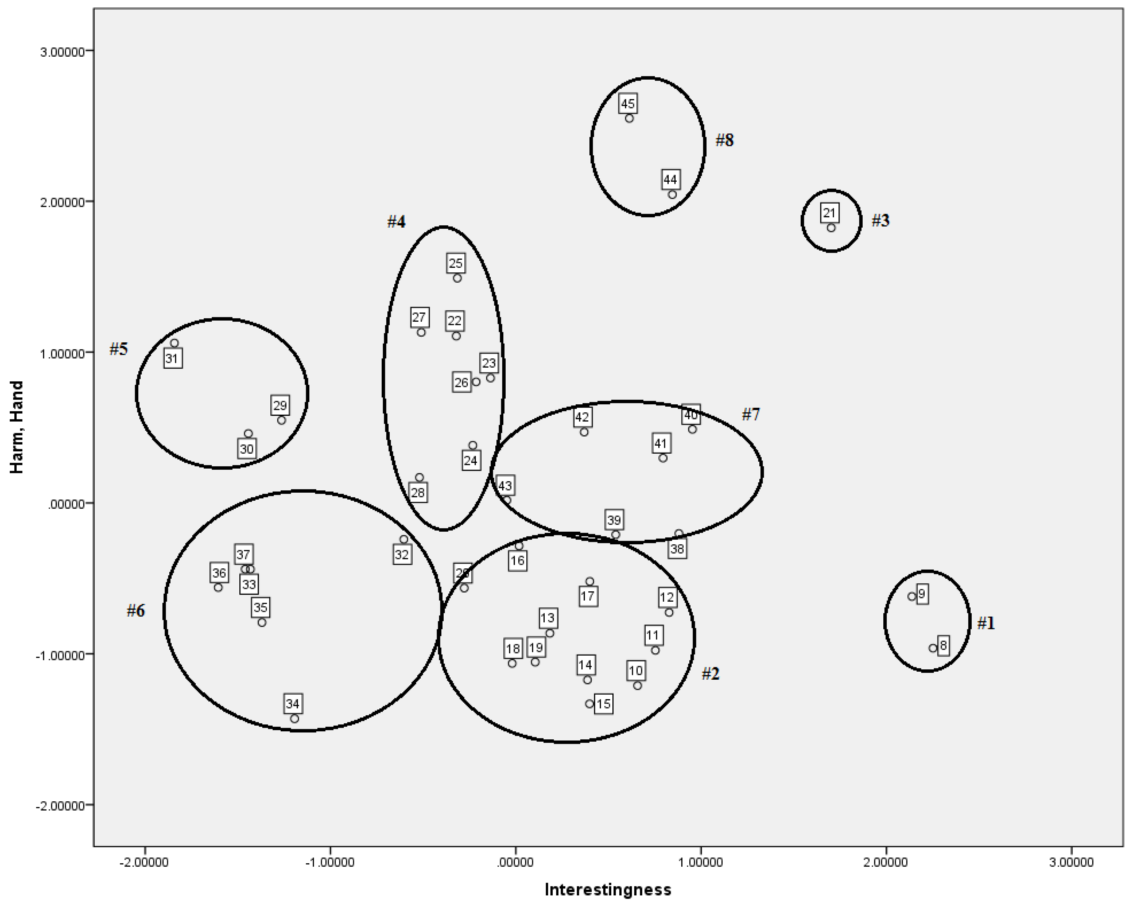

Figure 4.12. Clustering of mean bug scores along the interestingness factor and harmfulness factor.

Research Question #4. To identify the dependent variables that would predict participant interest for different types of interesting bugs, mean interestingness and attractiveness scores for each of the eight bug clusters were calculated for each participant. Attractiveness scores were calculated due to the empirical relationship between attractiveness and interestingness identified during analysis for research question #3. Using participant mean interestingness and attractiveness scores for the eight separate bug clusters, two RM-ANOVAs were conducted, one using the eight mean interestingness scores and the other using the eight mean attractiveness scores.

The RM-ANOVA for mean interestingness scores for each bug cluster violated the assumption of sphericity ($X^2_{(27)}$ = 474.60, $p < .001$), using a corrected Greenhouse-Geisser correction ($\varepsilon = .67$), there was a significant difference between the participants mean interestingness scores of the eight bug clusters ($F_{(4.69,\ 1363.63)}$ = 227.28, $p < .001$, r^2 = .44). A pairwise comparison using interestingness scores revealed that every bug cluster was significantly different from each other except cluster 5 and 6 ($p < .001$).

In a similar pattern, the RM-ANOVA for mean attractiveness scores for each bug cluster violated the assumption of sphericity ($X^2_{(27)}$ = 703.32, $p < .001$). Using a corrected Greenhouse-Geisser correction ($\varepsilon = .61$), there was a significant difference between the participants mean attractiveness scores of the eight bug clusters ($F_{(4.28,\ 1731.20)}$ = 456.86, $p < .001$, r^2 = .60). A pairwise comparison using attractiveness scores revealed that every cluster was significantly different from each other except for cluster 1 and 4 ($p < .001$).

Knowing that the participant mean values of interestingness differed between the eight bug clusters, another RM-ANOVA was conducted using animal reminder disgust scores and curiosity scores to predict interestingness scores between the eight bug clusters. Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated ($X^2_{(27)}$ = 436.08, $p < .001$), therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .68$). With a Greenhouse-Geisser correction, there was a significant difference for the main effect of bug clusters on overall interestingness scores ($F_{(4.74,\ 1309.23)}$ = 205.31, $p < .001$, r^2 = .41). The main effect of animal reminder disgust on interestingness scores was statistically significant ($F_{(2, 276)}$ = 4.03, p = .0019, r^2 = .03). The main effect for curiosity scores on interestingness scores was statistically significant ($F_{(2, 281)}$ = 7.65, p = .001, r^2 = .05) The interaction of animal reminder disgust with bug clusters was also statistically significantly between interestingness scores ($F_{(9.49, 1309.23)}$ = 4.26, p < .001, r^2 = .02). The interaction of curiosity with bug clusters between interestingness scores was not significant.

To test the interaction between bug clusters and levels of animal reminder disgust, an ANOVA was conducted using the least significant difference (LSD) post-hoc method. The ANOVA revealed that interestingness scores were significantly different between low, medium, and high levels of animal reminder disgust for bug clusters 2, 4, 5, 6, and 7 ($F_{(2,283)}$ = 11.26, p < .001, r^2 = .07; $F_{(2,283)}$ = 8.65, p < .001, r^2 = .058; $F_{(2,283)}$ = 5.65, p = .004, r^2 = .04; $F_{(2,283)}$ = 5.99, p = .003, r^2 = .04 and $F_{(2,283)}$ = 7.57, p = .001, r^2 = .05). Interestingness scores did not differ between animal reminder disgust levels for bug clusters 1, 3, and 8.

Due to the empirical relationship observed between attractiveness and interestingness identified during analysis for research question #3, it was concluded that the perceived attractiveness of a bug may affect the perceived interestingness. Subsequent analysis examining the relationship between attractiveness and interestingness was only conducted using the bug clusters which were significantly different between respondents levels of animal reminder disgust and curiosity scores (bug clusters 2, 4, 5, 6, and 7). Five hierarchical linear regressions (one for each bug cluster) were conducted using animal reminder disgust and curiosity scores as predictors of mean cluster interestingness scores as the first block with the second block introducing the mean cluster attractiveness score. For bug cluster 6, animal reminder disgust was significant (p < .001), however curiosity was not significant and the overall model only resulted in an R^2 = .06, so additional analysis was not conducted on this cluster. For bug clusters 2, 4, 5, and 7, animal reminder disgust and curiosity were both statistically significant predictors of mean cluster interestingness scores. Additionally, the inclusion of the cluster's associated attractiveness score reduced the standardized beta coefficient of both predictors (animal reminder disgust and curiosity), suggesting need for additional analysis for mediation effects.

Tests of mediation were conducted for bug clusters 2, 4, 5, and 7. (See Hayes, 2009; MacKinnon, Lockwood, & Williams, 2004; and Preacher & Hayes, 2004 for a detailed discussion on statistical procedures for tests of indirect effects). Two regressions were conducted for each cluster, one predicting interestingness scores by animal reminder disgust mediated by attractiveness scores and the other predicting interestingness scores by curiosity scores mediated by attractiveness scores. All tests of mediation implemented a bias-corrected bootstrap estimation approach with 5000 samples. For bugs in cluster 2 the linear regression model of curiosity and cluster 2 attractiveness scores explained 29% of the variance in interestingness scores (adjusted R^2 = .285). The indirect effect of curiosity scores on interestingness scores was not mediated through attractiveness scores and was not significant. The linear regression model of animal reminder disgust and cluster 2 attractiveness scores for bugs in cluster 2 explained 29% of the variance in interestingness scores (adjusted R^2 = .294). The indirect effect of animal reminder disgust score on interestingness scores was partially mediated through attractiveness scores and was significant (*b* = -.067, *SE* = .019, 95% CI = -.108, -.033).

For bugs in cluster 4 the linear regression model of curiosity and cluster 4 attractiveness scores explained 49% of the variance in interestingness scores (adjusted R^2 = .487). The indirect effect of curiosity scores on interestingness scores was partially mediated through attractiveness scores and was significant (*b* = .13, *SE* = .049, 95% CI = .042, .232). The linear regression model of animal reminder disgust and cluster 4 attractiveness scores for bugs in cluster 4 explained 48% of the variance in interestingness scores (adjusted R^2 = .48). The indirect effect of animal reminder disgust score on interestingness scores was partially mediated through attractiveness scores and was significant (*b* = -.078, *SE* = .021, 95% CI = -.122, -.040).

For bugs in cluster 5 the linear regression model of curiosity and cluster 4 attractiveness scores explained 26% of the variance in interestingness scores (adjusted R^2 = .26), however the indirect effect of curiosity scores on interestingness scores was not mediated through attractiveness scores and was not significant. The linear regression model of animal reminder disgust and cluster 5 attractiveness scores for bugs in cluster 5 explained 27% of the variance in interestingness scores (adjusted R^2 = .27). The indirect effect of animal reminder disgust score on interestingness scores was partially mediated through attractiveness scores and was significant (*b* = -.063, *SE* = .0183, 95% CI = -.104, -.031).

Lastly, for bugs in cluster 7 the linear regression model of curiosity and cluster 7 attractiveness scores explained 43% of the variance in interestingness scores (adjusted R^2

= .43), however the indirect effect of curiosity scores on interestingness scores was not mediated through attractiveness scores and was not significant. The linear regression model of animal reminder disgust and cluster 7 attractiveness scores for bugs in cluster 7 explained 41% of the variance in interestingness scores (adjusted R^2 = .41). Unlike the other bug clusters, the indirect effect of animal reminder disgust scores on interestingness scores was fully mediated through attractiveness scores and was significant (*b* = -.920, *SE* = .022, 95% CI = -.1405, -.0529).

Study 4 – Attentional Traits of Bugs

Descriptive Results. Study 4 measured the perceived interestingness of bugs and examined the visually attentive traits of interesting bugs by tracking the visual gaze of participants. Mean values for 'attractiveness,' 'harmfulness,' 'willingness to hold in hand,' and 'interested in learning more' scores were calculated for all 34 bug. As in Study 3, the highest possible score for 'interested in learning more' scores was a 5, for "extremely interested." The highest possible score for 'attractiveness' scores was a 7, for "very unattractive." The response categories for 'attractiveness' were recoded so that 7 was "very attractive." The highest possible score for 'harmfulness' scores was a 7, for "very not harmful." The response categories for 'harmfulness' were recoded so that 7 was "very harmful." And the highest possible score for 'willingness to hold in hand' scores was a 5, with 5 being "extremely willing."

Mean bug scores were calculated and compared to bug scores used in Study 3. Overall each bug score, "interested in learning more," "attractiveness," "harmfulness," and “willingness to hold in hand,” were significantly correlated with the same scores calculated in the Study 3 (*r* = .858**, *r* = .949**, *r* = .954**, and *r* = .926**, respectively). In a similar fashion, mean scores were calculated for each bug based on whether the bug was selected as “more interesting” during the side by side paired compassion section of the study (Part 1). If the bug was selected, the response was coded as a 1, otherwise the response was coded as a 0. Mean selection scores were calculated as percentages of times the bug was selected as “more interesting.” The five bugs that participants chose as “most interesting” were the monkey slug caterpillar (91%), the saddleback caterpillar (89%), the red-banded leafhopper (83%), the weevil (83%), and the tiger beetle (74%). Mean selection scores were compared with mean bug scores from both studies. The was a significant correlation between mean selection scores and mean bug scores of “interested in learning more” and “attractiveness” (*r* = .877**, and *r* = .500**, respectively), for bug scores in Study 4. There was also a significant correlation between mean selection scores and mean bug scores of “interested in learning more” and “attractiveness” (*r* = .922**, and *r* = .446**, respectively), for bug scores in Study 3. There were no significant correlations between selection scores and “harmfulness” or “willingness to hold” scores in either study.

Overall there were no significant differences in fixation data, bug scores, or bug selection scores between ordering effects of the experimental design. Another test of ordering effects was done to examine the counter balancing of interesting bugs compared to non-interesting bugs in the side by side paired compassion. Overall there were no significant differences in fixation data or bug selection scores between the counterbalanced positioning effects, therefore subsequent analysis was conducted normally using the entire data set.

Research Question #5. It was hypothesized that while viewing novel bugs, human visual fixation patterns would differ between bugs which are perceived as interesting compared to non-interesting bugs. Specifically, while viewing interesting bugs, respondents would fixate longer of the head of the bug. In contrast, while viewing non-interesting bugs, respondents would fixate longer on other areas of the bug, such as the body or appendages. To understand how respondents viewed interesting versus non-interesting bugs, mean scores were calculated for fixation duration (DUR), total fixations (FIX), and time to first fixation (TTFF). Specifically, mean values for DUR, FIX, and TTFF were calculated for the "head" area of interest (AOI) To calculate mean scores, bug types were split into four groupings. The first group was the eight most interesting bugs, followed by the nine somewhat interesting bugs. The other two groups were nine somewhat non-interesting bugs and the eight most non-interesting bugs (scores in Study 3 determined what bugs would be used in Study 4, these scores were used to form the groups).

Three separate repeated measures ANOVAs were conducted using mean DUR, FIX, and TTFF values for the four interesting bug clusters. Each ANOVA was conducted with a between-subjects factor indicating if the participant was an entomologist or not. Sphericity was assumed for each ANOVA as Mauchly's test was not rejected for FIX and DUR, however the test was rejected for TTFF ($X^2_{(5)} = 26.7$, $p < .001$, corrected using a Greenhouse-Geiser correction ($\varepsilon = .641$)). All three gaze values were statistically significant (DUR: $F_{(3, 105)} = 6.84$, $p < .001$ $r^2 = .15$; FIX: $F_{(3, 93)} = 8.38$, $p < .001$, $r^2 = .21$; TTFF: ($F_{(3, 105)} = 4.85$, $p = .003$, $r^2 = .12$).

For DUR scores, there was a significant difference in the interaction between gaze metrics for entomologists and non-entomologists ($F_{(3, 105)} = 4.85$, $p = .003$, $r^2 = .10$), indicating that for the four bug clusters, entomologists and non-entomologists spent different amounts of time fixating on the head. However due to the low statistical power of a small group size for entomologists (n=6), additional results for this interaction were not analyzed.

For FIX scores, a pairwise comparison between FIX scores of the four bug clusters using a LSD post-hoc method revealed that participants made more fixations on the head AOI of the most interesting bugs ($M = 13.53$, $SE = 1.16$) than the somewhat interesting bugs and the non-interesting bugs ($M = 10.49$, $SE = .66$, $M = 11.32$, $SE = .80$, and $M = 9.57$, $SE = .85$, $p = .001$, $p = .027$, and $p < .001$, respectively). The number of fixations made on bug "head" AOIs were not significantly different between the other three clusters, suggesting that fixations made towards the head of bugs for the somewhat interesting and both non-interesting bugs were statistically equal.

For TTFF, there was no significant difference in the main effect or interaction of entomologist. A pairwise comparison revealed that TTFF scores were significantly different between interesting and non-interesting bug clusters. To better understand the difference in TTFF metrics for interesting and non-interesting bugs, mean TTFF were calculated for all interesting bugs and all non-interesting bugs. A RM-ANOVA was conducted controlling for gender of the participant, year in school, and if the participant was an entomologist. Sphericity was assumed for each ANOVA as Mauchly's test was not rejected. There was a significant difference in TTFF between interesting and non-interesting bugs ($F_{(1, 28)} = 4.75$, $p = .038$, $r^2 = .14$). The main effect and interaction of all between subject variables were not significant. On average, participants made their first fixation on interesting bug's heads in 0.66 seconds (*SE* = .071) while taking 1.04 seconds to fixate on non-interesting bug's heads.

To examine another difference in TTFF between interesting and non-interesting bugs, mean TTFF for "body" AOIs were calculated. A RM-ANOVA was conducted, with entomologist added as a between subjects variable. There was a significant difference in TTFF values between "head" and "body" AOIs, sphericity assumed ($F_{(3, 93)} = 20.16$, $p < .001$, $r^2 = .39$). A pairwise comparison using a LSD post-hoc method revealed that both TTFF did not differ between interesting and non-interesting "body" AOIs (*M* = .44 seconds, *SE* = .061 for interesting bugs' "body" and *M* = .51 seconds, *SE* = .062 for non-interesting bugs' "body" AOIs). As before, the difference between interesting and non-interesting "head" AOIs was statistically significant (*M* = .65 seconds, *SE* = .067 for interesting bugs' "head" and *M* = .1.05 seconds, *SE* = .096 for non-interesting bugs' "head" AOIs, $p < .001$). The TTFF difference between non-interesting bugs' "head" AOIs was statistically significant from both "body" TTFF ($p < .001$ for both), while interesting bugs' "head" AOI was only different from non-interesting bugs' "body" AOIs ($p = .004$). Because TTFF was different between "head" AOIs and not "body" AOIs suggests that the heads of interesting bugs may have captured attention faster than non-interesting bug heads.

Research Question #6. It was theorized that while viewing novel bugs side by side, participants would pay more attention to interesting bugs than non-interesting bugs. To understand how respondents viewed interesting versus non-interesting bugs mean scores were calculated for fixation duration (DUR), total fixations (FIX), time to first fixation (TTFF), and duration of the first fixation (DFF). Similar to research question #5, bug were split into four groupings and mean scores were calculated for each group. A series of four repeated measures ANOVAs found there to be no significant difference in FIX, DUR, TTFF, or DFF between the four bug interestingness clusters.

A final analysis was conducted to determine if there was a difference in visual fixations between participants who viewed a scene with an image of either an interesting or non-interesting bug. The scene was a static image that resembled the inside of a museum. To understand how respondents viewed interesting versus non-interesting bugs, mean scores were calculated for fixation duration (DUR), total fixations (FIX), and time to first fixation (TTFF). Mean values for DUR, FIX, and TTFF were calculated for the interesting bug versus the non-interesting bug, as well as for the distractor image (tiger). A repeated measures ANOVA using DUR scores of the target (either the interesting bug or non-interesting bug, saddleback caterpillar or pill bug, respectively) and distractor (tiger), and a between subjects factor of the target type (indicating if the target was the interesting or non-interesting bug) and if the respondent was an entomologist were included in the full model. Sphericity was assumed for the ANOVA as Mauchly's test was accepted. There was not significant difference in DUR between the target and tiger image, additionally the main effect of target, entomology, and interaction of entomology with DUR scores were not significant. The interaction between DUR scores and target type was significant ($F_{(1, 31)} = 5.12$, $p = .031$, $r^2 = .14$). A pairwise comparison of DUR scores was conducted using a LSD post-hoc method. DUR scores for the tiger image for each participant was not statistically different (*M* = .580 seconds, *SE* = .088 and *M* = .589 seconds, *SE* = .108), while DUR values for the interesting bug was significantly different than the non-interesting bug ($p = .009$, *M* = .831 seconds, *SE* = .158 and *M* = .32 seconds, *SE* = .130). Both interesting and non-interesting bug DUR scores were significantly different from tiger DUR scores ($p < .001$ and $p = .005$, respectively). Because fixation duration was significantly different between the target bugs, the data suggest that when participants viewed the image with the interesting bug, they viewed the target bug more than they viewed the tiger image. However, participants who viewed the image with the non-interesting bug, viewed the bug image less than the tiger image. Figure 4.12 displays the mean difference in DUR between the target and distractor images, where DUR values are the same for the distractor image while DUR scores differ dramatically between the interesting and non-interesting target image.

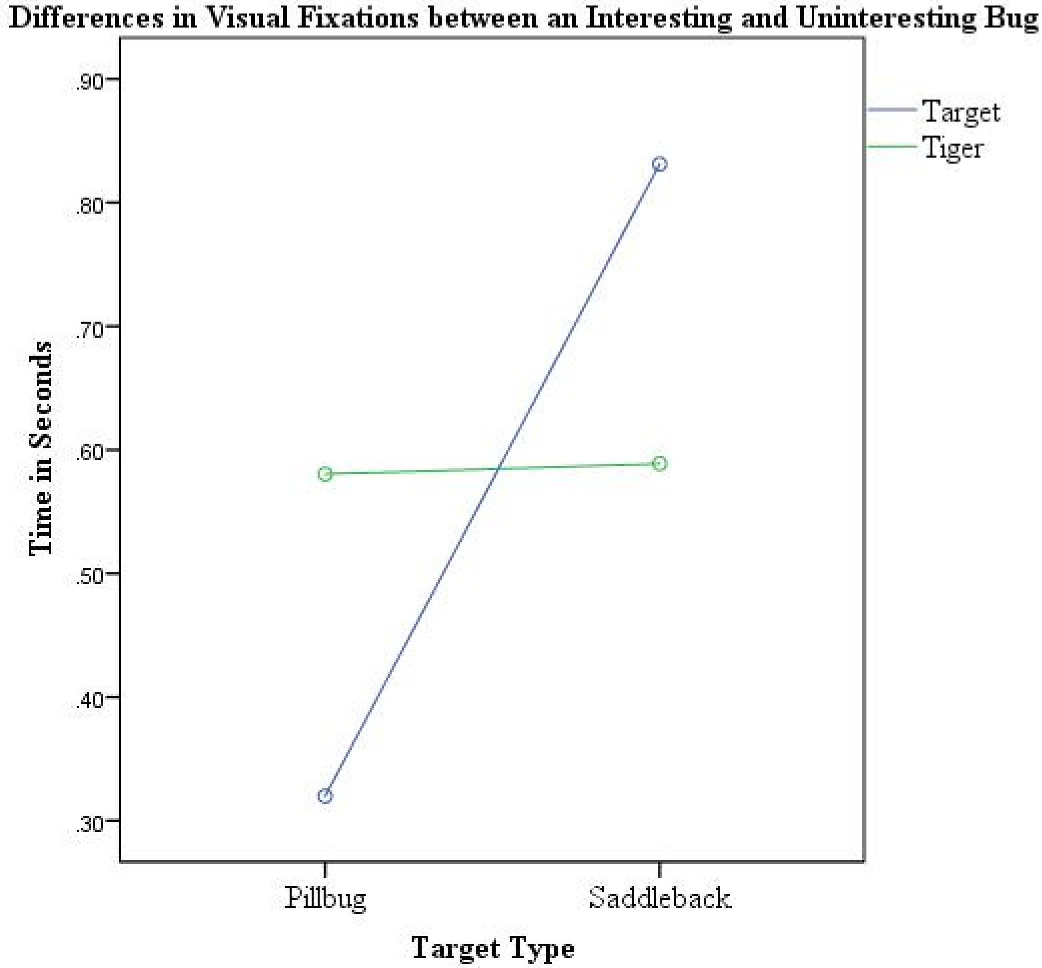

Figure 4.13. Differences in visual fixation duration between participants viewing an interesting bugs and an uninteresting bug. The interesting bug was the saddleback caterpillar and the uninteresting bug was the pill bug.

Result Summary

Four experimental studies provided empirical evidence that there are indeed many types of bugs that people are unfamiliar with. Of the bugs which are unfamiliar, there were many types of bugs that people reported as more interesting. Interesting bugs were fixated on differently than non-interesting bugs by the research participants, specifically by focusing more quickly on the heads of interesting bugs. A final empirical analysis revealed that an interesting bug captured more visual attention than a large, well-known, and charismatic mega fauna. These results suggest there are unfamiliar and interesting bugs that may be useful in capturing visual attention. The next chapter elaborates findings from the research studies for each relevant research question. A final conclusion is presented along with direct approaches to application of research findings, limitations, and future research.

CHAPTER V

DISCUSSION AND CONCLUSION

Overview

This chapter summarizes discussion and concluding remarks about findings from four integrated research studies. A detailed discussion for each research question is given. Following a discussion of research questions, a final conclusion is provided regarding the role that "interestingness" and novelty may have in capturing visual attention with unfamiliar and unknown bug types. Applications of research findings are briefly summarized, followed by study limitations and future directions of research findings.

Discussion of Research Questions

RQ #1: What bugs are people unfamiliar with? To conduct this study required identifying a pool of common but little known bugs that could be used in the research projects. Past studies had examined people's general knowledge about bugs, concluding that general knowledge about insects is low (Kellert, 1993; Schlegel et al., 2015; Shepardson, 2002; Snaddon & Turner, 2007). However, no study had systematically evaluated a general level of familiarity across a variety of biological and morphologically diverse bug types.

Data from Study 1 indicate that familiarity with bugs within the sample was disproportionately distributed among the 90 bug types used in this first study. In total, 63% of the bug types received mean familiarity scores of 2 or less (scored from 1 to 5, with 5 being "Extremely familiar"), suggesting that average familiarity with a majority of the sampled bug types was minimal. Furthermore, few participants could correctly identify bug types. Mean correct identification was less than 50% for 67 of the bug types (74% of bug types). There were several bug types where most respondents incorrectly identified the bug type despite reporting high familiarity (e.g., jumping spider, damselfy). The unique dissimilarities between familiarity and identification raised an intriguing question. Given that participants recognized the damselfly (17) yet incorrectly identified it, are subsequent subjective judgements made about the perceptual traits of the damselfly or of the dragonfly which was the common incorrect answer.

In the k-means cluster analysis, familiarity scores were used to cluster bug types into five unique familiarity clusters. There were only two bugs (lady bug and butterfly) clustered in the “Well Known” cluster, while 23 bug types were clustered into the “Unfamiliar” group and 37 types clustered into the “Unknown” group. Eight of the ten distractor animals were clustered into the “Well Known” group, while bat and snake clustered into the “Known” group. Given that the ladybug (48) and monarch butterfly (57) were clustered into the “well-known” group, clustered together with common household pets such as kittens, dogs, and hamsters, suggest that both of these bug types are ubiquitously known and recognized, a similar finding observed by Berenbaum (2008). In a study conducted by Shipley and Bixler (2017), they found similar results suggesting that butterfly and ladybugs are among the most well-known and favored bug types. Their results reflect findings from Study 1. Bugs clustered in the “Known” and “Familiar” clusters were bugs also reported by Shipley and Bixler (e.g., praying mantis, ant, bee, fly, cockroach, etc.).

Findings from Study 1 extend beyond Shipley and Bixler (2017), by providing additional insight into the “Unfamiliar” and “Unknown” bug clusters. Among the “Unfamiliar” and “Unknown” clusters, there are some unexpected results. For instance, firefly (or lightning bug, 28) was clustered in the “Unfamiliar” group, yet based on findings from Shipley and Bixler (2017), people generally report having played with fireflies at night as children. It is possible that the firefly received low familiarity scores in Study 1 likely as a result that identification of fireflies is based predominantly on their bioluminescence, which is a trait not apparent in a static image on a white background with the image illuminated in a manner typical of daylight. Another surprising result was low familiarity and identification scores for two pest bugs, the termite (in the Unfamiliar cluster, 88) and the emerald ash borer (in the Unknown cluster, 25). Termites are urban pests known to eat decaying wood and ultimately destroy parts of aged housing. Termites can be fairly common and due to their association with urban pest control, it is unexpected that only 18% of respondents correctly identified the termite. The emerald ash borer (EAB) is an invasive exotic agricultural pest that has decimated Ash tree (genus *Fraxinus*) populations throughout the northeastern United States. Due to high concern for this invasive specie’s potentially destructive force (with an estimated $10.7 billion US dollars to remove and treat ash trees between 2009 and 2019 (Kovacs et al., 2010), it is somewhat surprising that only three respondents (1%) correctly identified this bug.

Several generalizations are possible about familiarity with bug types. First, there are some common bug types that are recognized by everyone. A step down from this “Well Known” group of bugs are recognized by a majority of participants. Beyond the

Known bugs, there appears to be bug types that some people may be familiar with but the majority are not. Disaggregating lesser-known bugs into “Familiar”, “Unfamiliar”, and “Unknown” allowed this research project to systematically address what morphological traits of novel and unfamiliar bugs can capture attention and promote situational awareness.

In the subsequent study (Study 3) a similar method of analysis to the first study but with a different participant sample revealed that mean familiarity scores assigned to bugs were significantly similar between the two studies (r = .92**). Furthermore, the k-means cluster analysis with the greatest shared variance on mean bug familiarity scores collected in Study 3 produced a five cluster solution that was similar to the cluster solution identified in Study 1. Given that both studies produced similar results of familiarity scores and clusters between different samples of participants and some variation in method, provides an indication that the results were reliable across the four studies.

Beyond this research, the classification of bug familiarity groupings may be useful to environmental educators and practitioners choosing images for media who wish to catch the attention of people with information about bugs. The results should help professionals understand how and what people look at when viewing an unfamiliar image of a bug.

RQ #2: What are the predictors of familiarity with bugs? The focal purpose of Study 1 was to identify bug types with which people are generally unfamiliar. An extension of Study 1’s purpose was to begin identifying and disaggregating the different individual differences among people that are associated with higher knowledge and familiarity with bugs.

While research has documented that people have fairly limited knowledge about bugs, little research sought to identify unique predictors associated with increased familiarity with bugs. Kellert (1993) found that people with higher education and incomes had higher general knowledge scores about insects. Beyond knowledge, the literature concludes that males tend to have a higher preference for bugs (Byrne et al., 1984; Prokop et al., 2008; Schlegel et al., 2015; Schlegel & Rupf, 2010; Snaddon & Turner, 2007), that higher disgust sensitivity predicts less interest in bugs (Davey, 1994; de Jong & Merckelbach, 1997; Overveld, de Jong, Peters, Cavanagh, & Davey, 2007; Sawchuk et al., 2000), and that preference for outdoor leisure activities predicts preferences for insects (Schlegel et al., 2015). As an extension of these findings, similar predictive items were used in Study 1 to test if predictors of interest for bugs would predict familiarity with bugs.

Upon conducting analytic analysis for Study 1, the single item measurement of "outdoorsy-ness" were the only items that were statistically significantly related to familiarity scores. The relationship between self-perceived "outdoorsy-ness" was not significant in predicting familiarity with bugs in the "Well Known" familiarity cluster. In addition, no additional predictors explained variation between familiarity scores of the Well Known bugs, suggesting that people are likely equally familiar with bugs in this cluster. Outdoorsy-ness was a significant predictor of variation of familiarity scores of bugs in the "Known", "Familiar", "Unfamiliar", and "Unknown" bug familiarity clusters.

The relationship between outdoorsy-ness with bug familiarity increased as mean familiarity scores decreased. The relationship was most significant in predicting familiarity with bugs in the “Unfamiliar” bug familiarity cluster, while the statistical significances of “outdoorsy-ness” decreased in size for bugs in the “Unknown” clusters. The differences observed between outdoorsy-ness and familiarity scores between the four bug clusters suggest that people who are more outdoorsy are more familiar with bugs that are on average lesser known. For bugs that are on average unknown, people who identify as being outdoorsy no longer are as familiar with bugs, suggesting that these bugs may be too foreign, novel, or alien that even experience in nature does not provide adequate experiences with these bugs.

Surprisingly, the relationship between outdoorsy-ness and familiarity with bugs was less statistically significant in data collected from Study 3. Another finding between the relationship of outdoorsy-ness and familiarity in Study 3 was that outdoorsy-ness predicted less variance as mean cluster familiarity decreased. Between Study 1 and Study 3, the most notable difference between outdoorsy-ness predicting familiarity with bugs was that the significant effect between outdoorsy-ness and familiarity scores with bugs in the “Unfamiliar” cluster. In Study 1 outdoorsy-ness predicted nearly 13% of the variance (r^2 = .123) in familiarity scores for bugs in the “Unfamiliar” cluster, while in Study 3 outdoorsy-ness only predicted 3% (r^2 = .03) of the variation in familiarity scores for bugs in the “unfamiliar” cluster. The difference in this observation is peculiar given that both samples were nearly identical in reported levels of outdoorsy-ness. The differences observed between the two studies could be due to the weak psychometric strategy of measuring perceived level of outdoor activity participation based on a single question. However, in both studies, high level of outdoorsy-ness was always significantly related with being more familiar with bugs aside from the Well Known bugs.

Aside from outdoor levels and locus of control, there appeared to be minimal statistically significant relationships between familiarity scores and other metrics. Overall there were no relationships between familiarity and gender, age, level of education, having made an insect collection, or ever taken an entomology course. Somewhat surprising was the lack of a gender difference given the extant literature identifying a gender difference between preference ratings of bugs.

Analytically, both bug experience questions were relatively skewed with only 18% of participants reported having made an insect collection and 15% ever taken an entomology course. A method that systematically disaggregates formal instruction with insects would be needed to confirm more rigorously the nature of the relationship between past experiences with bugs in predicting familiarity with bugs.

Of the scale items, the desire for modern comforts scale did not predict overall familiarity scores. As with gender, it was surprising to not identify a desire for modern comforts as a predictor of familiarity with bugs given the amount of relevant literature on the correlation between disgust-sensitivity and disregard for bugs. The absence of a significant effect of desire for modern comforts could come from the nature of the question itself, given that the scale was an indirect measure of disgust-sensitivity (and fear). It was determined that disgust-sensitivity may still predict interest in bugs given findings from Shipley and Bixler (2017). Therefore, a sensitivity to disgust scale was used in subsequent studies,

Of the scale items used in Study 3, curiosity scores significantly predicted bug familiarity scores, however this relationship was small. Disgust-sensitivity, exploration, dominance, and prestige scores were not significantly related with bug familiarity scores. The minimal relationship between predictors and bug familiarity scores suggests that familiarity with bugs used in Study 3 is relatively low across all participants.

RQ #3: Which unfamiliar bugs are perceived as being interesting? After determining the degree of familiarity with different bug types in Study 1, interviews were conducted to begin developing a general overview of how different bugs are perceived. General first impressions reported by research participants were mostly physical descriptions of bugs, such as indicating the color of the bug was unique or the presence of some unique morphological trait (big eyes, wings, etc.). Rarely did participants describe unfamiliar bugs with traits that expanded beyond general physical appearance. When participants did describe a subjective term rather than an external trait, responses were often strongly dichotomized as good or bad. “Bad” descriptive terms included scary, dangerous, bad, eeeewwww, and gross, while “good” descriptive terms included cool, pretty, interesting, and cute. As found in past research (Kellert, 1993), participants assigned few humanistic descriptive terms to any of the bug types. The strong dichotomy and lack of humanistic traits suggest that first impressions of novel and unfamiliar bugs may be based on the visual traits of the bugs or comparison with other bugs that are similar visually/morphologically that the participant has had a previous experience with.

Finally, interviews are linguistically demanding. When participants do not know the terms needed to describe their reactions or what they are reacting to, they often do not share their perceptions.

Following interviews, Study 3 systematically evaluated unfamiliar bug types across metrics of interestingness, attractiveness, and perceived threat. Early descriptive analysis revealed that of the unfamiliar bugs, the saddleback caterpillar (74), monkey slug caterpillar (59), red-banded leafhopper (71), two-striped planthopper (94), and weevil (99) were the top five most interesting bugs based on subjective interestingness scores. Notably, four of the five most interesting bugs were clustered in the Unknown bug familiarity cluster, with the fifth (two-striped planthopper), being clustered in the Unfamiliar bug familiarity cluster. Additionally, there was a moderate correlation between mean bug interestingness and familiarity scores. Unfamiliar bugs tend to be perceived as more interesting the more unfamiliar they become, supporting the hypothesis that novelty of unfamiliar bugs promotes subsequent interest. (Berlyne, 1966; Hidi & Baird, 1986; Kashdan, Rose, & Fincham, 2004).

While the k-means cluster analysis using mean bugs scores of interestingness, attractiveness, and harmfulness metrics did not produce any strong statistical insights, the analysis did reveal that bugs with high interestingness scores were not assigned within the same attractiveness or harmfulness clusters. The different organization of interesting bugs across clusters suggested that different types of unfamiliar interesting bugs may exist. A k-means cluster analysis using factor scores of mean bug metrics (attractiveness, harmfulness, interestingness, etc.), revealed that there were different types of unfamiliar and interesting bugs. The cluster method resulted in an eight-cluster solution. Three of the clusters were small and distant from the remaining five clusters. The first cluster contained the two bright and colorful caterpillars, the saddleback (74) and monkey slug caterpillar (59). Both caterpillars had the highest average interestingness scores, yet also had fairly high harmfulness scores and low attractiveness scores. Due to the bright and attractive colors of both caterpillars, it was peculiar that both were assigned low attractiveness scores. Descriptive data for each caterpillar gathered in Study 2 suggests that both were described as hairy and fuzzy with colorful bodies, and as cool and cute. Data from both studies suggest that the bright colors alone are not the sole perceptual basis for both caterpillars perceived interestingness, but rather an interaction of their bright coloration with perceptually novel and unusual traits such as spikes and being fuzzy.

Both the third and eighth clusters contained similarly bright and colorful bugs, the red-banded leafhopper (71), the katydid (45), and the two-striped planthopper (94). The bugs in each cluster were rated highly interesting and highly attractive, suggesting that all three bugs are likely perceived as interesting due to their perceptually attractive colors. The major difference between the two clusters is that both bug types are green and resemble leaf shapes, while the red-banded leafhopper is brightly colored with greens, yellows, and red colorations across the entire body. Both the two-striped planthopper and katydid were described as cute and cool green leaf shaped bugs in Study 2, while the red-banded leafhopper was also described as pretty and cool with bright colors, with some people describing the bug as friendly looking. In contrast to the caterpillar cluster, it is likely that leafhopper, planthopper, and the katydid are perceived as interesting mostly due to their bright and attractive colorations and simple shapes.

The cluster with the lowest average interestingness score (cluster five) contained three bugs, the millipede (56), pill bug (67), and eyed click-beetle (27). This cluster had low attractiveness scores and low harmfulness scores. The millipede and pill bug were described as having many legs and armored bodies, while the click beetle was mostly described by the presence of two large fake eye spots on the front of the insect. These bugs are likely uninteresting due to their lack of attractive color and lack of any overtly unique morphological characteristics.

The second, fourth, sixth, and seventh clusters contained the majority of the bug types used in Study 2 and Study 3. These four clusters provided the most insight into understanding the different types of interesting bugs. Looking at Figure 4.11 in Chapter 4, it becomes clear that these four clusters are more similar to each other than the other clusters. Each cluster was uniquely distributed along the interestingness and harmfulness factor scores, with cluster six assigned low interestingness and high harmfulness scores and cluster four was assigned low interestingness and low harmfulness scores. In contrast, cluster two was assigned high interestingness scores and high harmfulness scores while cluster seven was assigned high interestingness scores and low harmfulness scores. The differences observed between these four clusters begins to suggest that the majority of unfamiliar bugs used in this study can be dichotomized into two types of interestingness, bugs which are interesting given their bright colors and relative attractiveness and those bugs whom are interesting given their rather unique and perceived harmful morphological traits.

Bugs in cluster four are those bugs with lower interestingness scores but relatively low harmfulness scores and high interestingness scores. Bugs that typify cluster four bugs are the emerald ash borer (25), cicada (11), dragonfly (20), and the shiny flea beetle (80). These bugs can described as either attractive in color or rather simple in shape. The emerald ash borer was described in Study 2 as a colorful, pretty, and shiny green bug. Similarly, the shiny flea beetle was described as a bright and interesting shiny red bug. Both the dragonfly and cicada were described as winged bugs with large notable eyes. It is likely that bugs in this cluster are those who either are colorful but lack novel morphological traits or those which are not colorful but have some external traits which are perceptually more interesting than the bugs clustered in the extremely low interesting cluster five bugs.

In contrast to the bugs in cluster four, bugs in cluster seven are assigned higher interesting scores and are equally described as bright and colorful bugs or those with unique morphological traits that are perceived as attractive and not harmful. Bugs that illustrate cluster seven bugs are the hickory horned devil (38), milkweed bug (54), tiger beetle (90), and the weevil (99). Similar to bugs in cluster four, the milkweed bug and tiger beetle are described as colorful bugs, but more perceptually "weird" or "cool" than the colorful bugs found in cluster four. The hickory horned devil and weevil were described in Study 2 as having more unique external morphological characteristics such as horns, spikes, long nose, and mouth parts. The weevil was described as cute and fuzzy while the hickory horned devil was described as alien and perhaps dangerous. It is likely that bugs in cluster seven are comparable to bugs in cluster four based on their harmfulness and attractiveness but differ in their perceived interestingness. Bugs in cluster seven represent the first type of interesting bugs, those bugs that are either pretty and colorful or not perceived as harmful.

The second type of interesting bugs are those which are not attractive or colorful, but rather are perceived as interesting for their novel morphological traits and characteristics. Cluster two bugs represent the interesting bugs that are likely perceived as harmful. Bugs that exemplify cluster two are the mantidfly (53), scorpionfly (77), and ichneumon wasp (32). None of these are actually harmful. These bugs were assigned high interesting scores with high harmfulness scores and low attractiveness scores. These bugs were mostly described in Study 2 by their unique traits, for instance the ichneumon wasp was described by the long ovipositor which respondents perceived to be a large stinger and perceived potential danger. The mantidfly was described as a cross between a wasp and a praying mantis, as participants often noted the arms and their perceptions of the bug having a stinger. The scorpionfly was most described by its scorpion-like tail and (supposed) stinger as well as its head and large beak-like face. As these bugs were all not colorful nor attractive yet rated as highly interesting, it is likely that these bugs represent a different type of interesting bug in contrast to the interesting bugs identified in cluster seven.

The final bug cluster, cluster six, represented bugs that are comparable with bugs in cluster two. Bugs in cluster six are perceived as not interesting but harmful, and are assigned low attractiveness scores. Example bugs in cluster six are the assassin bug (2), giant water bug (33), and earwig (24). These bugs were all described as gross, dangerous, and bad in Study 2. It is likely that bugs in cluster two are perceived as equally harmful and attractive as bugs in cluster two, yet are not interesting compared to those in cluster two.

By clustering bugs across levels of perceived interestingness, attractiveness, and harmfulness, two primary types of interesting bugs were identified. The two primary types of interesting bugs were those which were attractive and colorful in contrast to the second type of interesting bugs, which are not inherently attractive but rather display unique morphological traits that are perceived as potentially harmful. In the endeavor to identify unfamiliar bugs which are interesting, discovering the existence of disparate types of interesting bugs provides insight into better understanding why specific bugs are perceived as interesting. A key aim of the fourth research study was to evaluate traits of bugs that capture visual attention by comparing interesting bugs to non-interesting bugs. By identifying the two unique types of interesting bugs, subsequent analysis of visually attentive bug traits was operationalized around assessing the differences between the two interesting bug clusters and each non-interesting bug clusters.

In Study 4 participants were asked to give subjective scores for each bug that was presented to them, similar to methods used in Study 3. There was a significant correlation for bug attractiveness, harmfulness, willingness to hold, and interested in learning more scores between Study 3 and Study 4. An extension in Study 4 was that participants viewed two bugs side by side simultaneously and asked to indicate which of the two bugs they would most like to learn about. Using an average score based on the number of times selected, there was a significant correlation between selection scores and interesting scores from both Study 3 and Study 4. Similarities between these two studies, which utilized two independent and dissimilar samples of people, begin to validate the perceived degree of interestingness for different bugs. The correlation between selecting interesting bugs and rated subjective scores suggest that bugs rated as interesting are indeed more likely to be picked as a bug respondents would like to learn about when shown multiple bugs.

RQ #4: What are the predictors of general interest in bugs? The final analysis of Study 3 was operationalized around identifying what individual differences between the participants predicted higher interestingness scores for bugs. Past research examining human-bug interactions has found that females report higher distaste for bugs while in comparison those who participate in nature-related outdoor recreation tend to rate bugs as more pleasing (Byrne et al., 1984; Prokop et al., 2008; Schlegel et al., 2015; Schlegel & Rupf, 2010; Snaddon & Turner, 2007). It was hypothesized that because gender and preference for outdoor recreation predict affinity for bugs, that both variables may predict interest in bugs. In addition, a further hypothesis examined how individual differences in sensitivity to disgust might predict interest in bugs.

In Study 3, there were minimal relationships between the hypothesized predictor variables and interest in unfamiliar bugs. There was a noticeable relationship between animal reminder disgust scores and curiosity scores with bug interest scores across different types of bugs. Curiously, of the eight bug clusters identified in previous analysis, disgust and curiosity scores were only predictive of interestingness scores for bugs in clusters 2, 4, 5, 6, and 7. The relationship between each variable and interestingness scores was very small for cluster 6 and therefore likely not an important finding. Of the bug clusters 1, 3, and 8, there were no variables that predicted interest in these bugs. Bugs in clusters 1, 3, and 8 are all bugs assigned high interestingness scores and are all seemingly bright, colorful, and perceived as attractive. Quite possibly, no variables predicted interest scores for these bugs given that on average most people are interested in these bugs. Similarly, the small relationship between disgust and interesting scores for bugs in cluster 6 likely is a result of minimal average interest scores assigned to these bugs. In contrast to bugs in cluster 1, 3, and 8, it is likely that few people are interested in these bugs.

While curiosity and disgust scores predicted interest in four different bug clusters, understanding the relationship between each cluster required a separate analysis. For bugs in cluster 2, (interesting and harmful bugs), the relationship between disgust sensitivity and interest was mediated by mean attractive scores assigned to the cluster. Because attractive scores partially mediated the relationship between disgust and interest, it is likely that interest in these bugs is not reduced simply due to higher disgust sensitivity, but rather high disgust sensitivity results in a reduction of perceived attractiveness of these bugs, ultimately producing a lessened interest. Furthermore, because the relationship was partially mediated, some residual effect of disgust sensitivity is influencing assigned interestingness scores beyond perceived attractiveness. Curiosity scores were not mediated by attractiveness scores for bugs in cluster 2, suggesting that interest in these bugs extends beyond attractiveness versus non-attractiveness. Similarly, the relationship between disgust and interest scores for bugs in cluster 5 were partially mediated by attractive scores while curiosity scores were not. The difference between each cluster is that bugs in cluster 5 were all assigned low interestingness scores while bugs in cluster 2 were assigned high interestingness scores. Unfortunately, this study did not provide an additional metric in which to explore predictors of interest for bugs in clusters 2 and 5.

Bugs in cluster 7 are those which are attractive and interesting. Like the prior cluster, curiosity was not mediated by bug cluster attractive scores. Unlike the previous cluster, disgust scores were fully mediated by attractiveness scores. This suggests that differences in disgust sensitivity has little residual influence on perceived interestingness beyond perceived attractiveness. It is likely that people who do find these bugs to be attractive are more likely to find them more interesting.

Bugs in cluster 4 are those that are attractive but not interesting. Unlike the previous clusters, both curiosity and disgust sensitivity were partially mediated by mean cluster attractiveness scores. It is likely that while these bugs are less interesting than their interesting counterparts in cluster 7, there are people who find them to be more interesting largely as a result of their perceived attractiveness.

RQ #5: What traits of bugs capture visual attention? To understand the traits of interesting bugs that capture attention; static images of bugs were shown to participants. The most interesting finding was a difference in the time to first fixations on head areas of interests (AOI) between interesting and non-interesting bugs, where participants fixated on the heads of interesting bugs quicker. Short times to first fixations may be associated with more unconscious visual processing (Bushwell, 1935; Follet, Le Meur, & Baccino, 2011). The difference in time to first fixations for head AOIs of interesting bugs suggest that participants were likely first fixating on the interesting bug heads unconsciously. In comparison, the slower fixation times for non-interesting bug heads suggests that fixations were more consciously driven, likely as a function of visual search behavior.

The literature states that people pay much detail and attention to faces of people (Haxby et al., 1994; Theeuwes & Van der Stigchel, 2006; Yarbus, 1967), after all humans are social creatures and we present a lot of non-verbal commutation through our faces (Haxby, Hoffman, & Gobbini, 2002). Human face perception is an important component of our social behavior, so much so that humans have several areas in the brain dedicated to face perception (Kanwisher, McDermott, & Chun, 1997). We are likely somewhat evolutionary prepared to view faces of humans quickly and rapidly (Fridlund, 1991). Another trait of human preference that is likely evolutionarily prepared is human preference for creatures that exhibit neotenic traits (Estren, 2012), such as large heads and large eyes. This study did not provide a clear examination of neotonic traits, but the difference in time to first fixation for bug head AOIs suggest that fixation on interesting bug heads is important. Given that humans tend to prefer neotenic traits in animals while also focusing on human faces, it is possible that time to first fixations are shorter for interesting bug head AOIs because of neotenic or some other humanistic trait.

RQ #6: Are interesting bugs gazed upon longer than non-interesting bugs?

To further understand how interesting bugs capture visual attention in comparison to non-interesting bugs, images of bugs were shown side by side to participants. However there were no relationships observed in fixation data between interesting and non-interesting bugs. It is likely that the nature of the experiment itself may have been cause for the lack of statistical relationships. By having two images of bugs shown at the same time, one of the left and one on the right, there appeared to be many visual fixations made quickly to the left and right in quick succession. In previous studies using this procedure (Dixson et al., 2014; Nummenmaa, Hietanen, Santtila, & Hyona, 2012), AOIs were drawn around specific target areas. In this study, the only target AOI was the entire bug, rather than specific areas. Due to a limitation of time, AOI were not identified for each bug in this analysis. A further analysis could look at if specific areas of interest captured more attention than others.

While the side by side comparison provided little in terms of discernible empirical results, the differences observed between the interesting saddleback caterpillar and the non-interesting pill bug were different. In the static museum image shown to participants, there was a significant increase in the time spent fixation on the saddleback caterpillar than the pill bug. Not only did fixation patterns differ between the interesting and non-interesting bug, but fixations were identical between participants for the comparison image (tiger). This suggests that interesting bugs (saddleback) did capture more visual attention than the non-interesting bug and the distractor tiger image. While this finding was significant, it is important to note that the saddleback was not the focus of all visual fixations made while viewing the whole image. As seen in Figure 5.1 there are fixations on the saddleback caterpillar, but there are still other areas of fixation around the entire scene. In analysis, these points were not of interest. While the data analysis showed the saddleback did catch more visual fixations than the tiger, future research is needed. However, this study provided empirical evidence to suggest there is an effect that should be studied in greater detail.

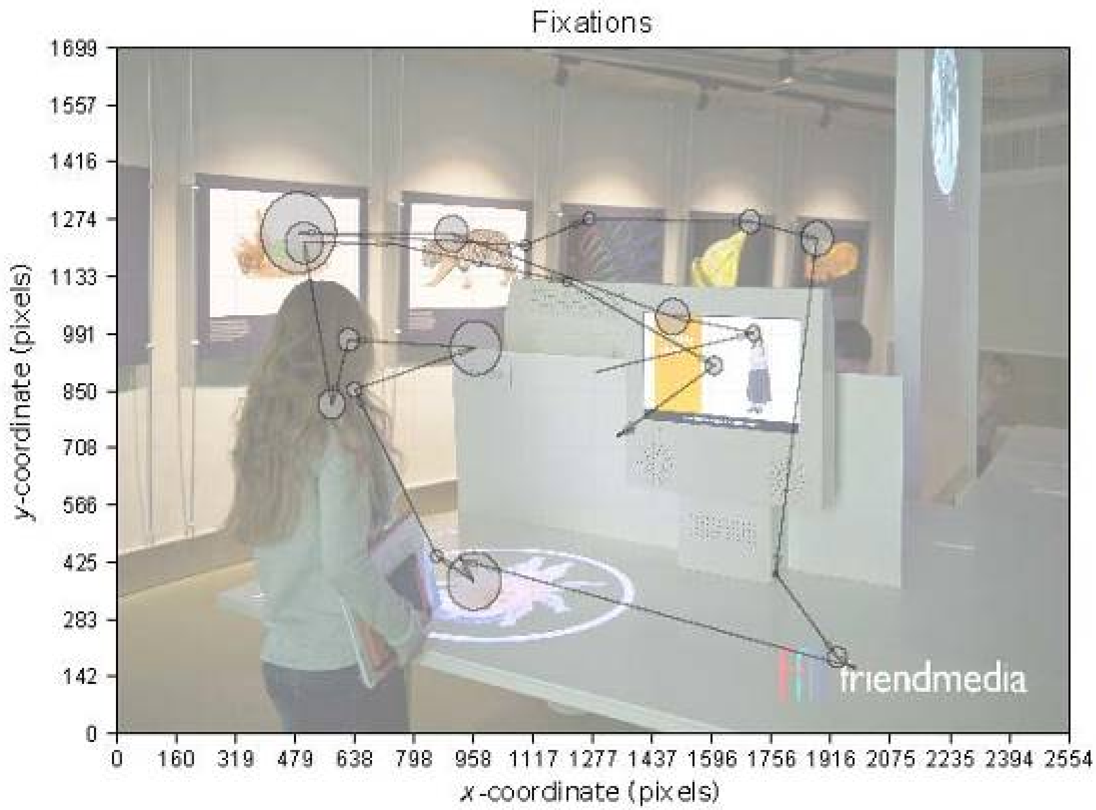

Figure 5.1. Visual fixations made by one participant while viewing a museum scene.

Conclusion

Bugs are among the most disliked organisms on earth (Kellert, 1993; Lockwood, 2013). They are the focus of horror movies, disdained for their presence in our homes, and used as negative psychological anchors in implicit research (Greenwald, McGhee, & Schwartz, 1998). However, it has been suggested that experiences with bugs are worthwhile during childhood development, that interactions with bugs may provide a gateway to future experiences in nature (Shipley & Bixler, 2016). Because emotional and intellectual connections with bugs are rarely made in school and formal educational settings (National Research Council, 1996), informal education and play settings may provide an alternative for positive experiences for bugs to occur. As in most leisure settings, participation is self-selective. The challenge of promoting positive interactions with bugs is the minimal motivation to interact with these seemingly unimportant species.

Because bugs are widely unknown, it was hypothesized that many bugs are likely novel. Through novelty, it was hypothesized that some bugs may in fact be considered interesting. As Shipley and Bixler (2017) have suggested, it is the bugs that are unfamiliar and interesting that may be useful in promoting motivation to interact with bugs. A further hypothesis posed that unfamiliar and novel bugs may be interesting and may capture visual attention.

To determine if interesting bugs do capture visual attention, a metric was needed to establish which bugs are interesting. Because it was predicted that novel bugs are interesting, another index of unfamiliarity was needed. The first study of this research sought out to set an index that could be used to assess the relative novelty and unfamiliarity of a bug. Results from thus study support previous findings that indeed; many bugs are unfamiliar. Using empirical data from this study, it was suggested there are roughly five types of familiarity with bugs; where the first category are bugs that are so familiar they are ubiquitous. The next two groups contained bugs which are known or familiar; including bugs commonly reported in previous studies (Schlegel & Rupf, 2010; Shipley & Bixler, 2017; Snaddon & Turner, 2007). However the other two groups, the unfamiliar and unknown contained the majority of bugs presented in this study, suggesting that these bugs are indeed unfamiliar.

After establishing bugs that were known and unknown, Study 2 and 3 of this research sought to understand what unknown bugs are considered interesting, while also seeking to better understand the subjective perceptions of these creatures. The second study provided evidence that many subjective appraisals of these bugs are made in a very descriptive manner with little descriptions included variables that one might use to describe something more humanistic. The overall lack of variability in descriptions suggest that the conscious introspection of viewing these creatures is rather limited.

In Study 3, it was found there are some bugs that are considered interesting. The data suggests that interestingness was related with unfamiliarity, such that the more unfamiliar a bug was the more interesting it was perceived as. Additional analysis revealed that there are many types of interesting bugs. There appeared to be interesting bugs that were attractive and not harmful while others that were unattractive and harmful. Of these diverse bug groupings, it appeared that individual differences in participants in sensitivity to disgust and curiously predicted interest in these different creatures. This suggests that different classifications of interesting bugs could be targeted to unique subsets of the population

After identifying interesting bugs, Study 4 established that respondents quickly fixated on the heads of interesting bugs. The study also identified that participants viewed an interesting bug more than they did a non-interesting counterpart.

Application

People are generally disinterested in bugs and therefore unlikely to interact with them willfully. This research sought out ways to motivate interest in a topic in which interest does not exist; by focusing on the attention grabbing, novel, and interesting external morphological characteristics of bugs. In Study 1, people evaluated their familiarity with 90 different bug types. For the interpretive naturalist, understanding which bugs are known or unknown by the general public is helpful in the design of programs intent on promoting positive human interactions with bugs. Following recommendations from Shipley and Bixler (2017), unfamiliar bugs fit the programmatic needs of an insect scavenger hunt or “insect safari.” Findings from Study 1 can also inform which bugs can be used in interpretive programs to fill gaps in knowledge of bugs, motivating people to engage with FUN bugs (Shipley & Bixler, 2017).

Study 2 and 3 elaborated on the general emotions evoked by unfamiliar and novel bugs, identifying multiple dimensions of “interestingness”. Understanding the different emotional perceptions by non-entomologists towards unfamiliar bugs is useful for environmental educators and interpreters in deciding what bugs to use in programs as to evoke certain emotional connections.

Data collected throughout this research revealed the bug types rated as most interesting were the two colorful caterpillars. Based on finding from Study 4, bugs which are colorful and ambiguous in shape are likely to capture attention. While it was not the focus of the static museum image, it could be theorized that interesting bugs which are colorful or perceived as harmful may also capture visual attention. For an environmental interpreter, visual media creator, marketer, or museum curator, presenting images of these interesting bugs may be useful in capturing people's visual attention. Using images of interesting bugs such as the saddleback caterpillar on museum signage or in nature centers could result in people viewing the signs in further detail, resulting in increased focus and situational interest.

Findings from Study 4 inform an environmental educator’s decision about what bugs to display on an informative or promotional piece. Findings from Study 1, 2, and 3 then inform what ecological story about each bug’s natural history should be attached to an informative or promotional piece as a subsequent motivator of further behavior beyond capturing visual attention.

Study Limitations

The primary limitations of this research were the limitations of time and available resources. In particular, this research did not provide any insight as to how the study’s findings might actually influence behavior in real scenarios. Because the study collected data in a controlled environment, generalizations to real life contexts may not be valid. Catching attention in the real world involves competing against a diverse and wide array of various stimuli all trying to compete for the attention of the user. In these studies, only two-dimensional images were used, while real world settings offer a far more complex world in which to interact with bugs. The scope of this research was to identify bugs that capture visual attention by focusing on first impressions. This research did not focus on what happens after people's first impressions with novel and unfamiliar bugs.

Another limitation of this study is the lack of age differences in the participants. The literature suggests that the perceptions of bugs may vary between children and adults. Where what adults may find to be a negative disgust reaction, children between the ages 8 and 10 might find appealing. Due to the inherent focus of the research, catching children's attention and interest in bugs is just as important as catching an adults attention, as children are the ones who are the target of many interpretive programs about natural history. However, due to the restriction of usage with the laboratory's stationary eye tracking equipment, to get children's gaze data would involve bringing participants to the lab, requiring parents to bring their child to the testing facility. Due to this improbable request without being able to provide a sizeable compensation, the study did not include children in data collection.

Future Research

Suggestions for future research for this project emerge from the study's limitations. Future directions could involve analyzing if or how interesting bugs can be used to motivate behavior. Specific research questions could explore how using interesting bugs images displayed on signage in museums and nature centers may entice people to view the sign more or recall more information about a sign that displayed an interesting bug. Another question might evaluate if an image of an interesting bug would capture visual attention in real life scenarios, where naturalistic observation and field experiments would reveal how the different attentive and perceptual traits of bugs motivate specific behaviors.

Another facet of future research includes examining the specific emotions elicited beyond first impressions of the novel and unfamiliar bugs. By examining the emotional responses that people have towards different life histories of bugs, environmental educators and interpreters can chose what bugs to use in programs to promote specific emotional connections with different bugs.

Other future directions include the direct manipulation of various bug traits. Where traits could be digitally manipulated through software to change their size, shape, etc. This direction would reduce the usefulness of the findings for applied use, however it might reveal a better explanation for how these traits catch and maintain attention. Another direction could involve the manipulation of the bugs position or orientation utilized in the study. Different bugs may be observed from different perspectives. For instance, in the real world a cockroach is typically viewed from above while a grasshopper is often viewed from the side.

Final thoughts for future research include natural extensions of evaluating different bugs. Additional research could continue to identify bugs which are known and unknown by the general public. Future research could involve the analysis of age differences in attentive and perceptual qualities of different bug species. Lastly, research could expand beyond this study and identify additional traits or predictors of familiarity and interest in bugs.

APPENDICES

Appendix A

<u>100 Images of Bugs and Other Wildlife</u>

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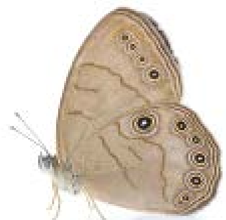

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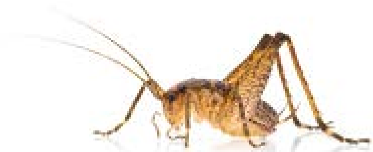

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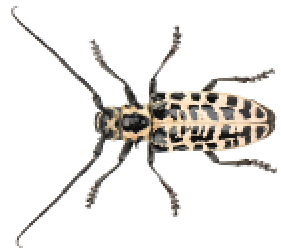

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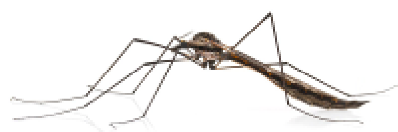

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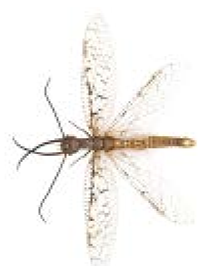

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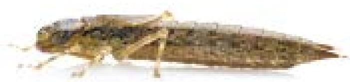

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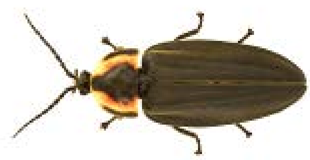

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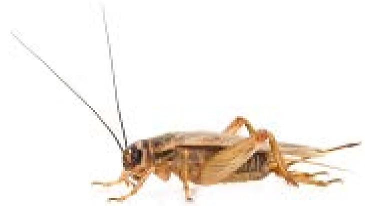
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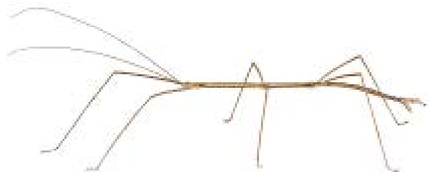

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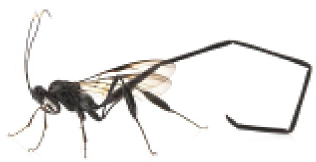

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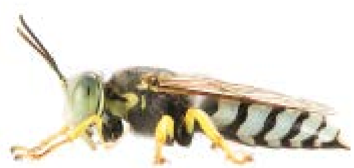

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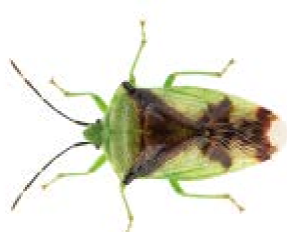

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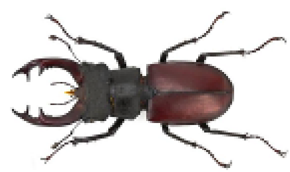

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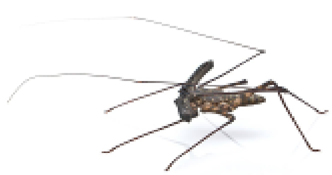

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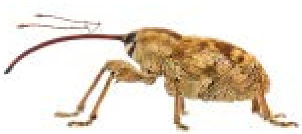

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Appendix B

Study 1 Survey Questions

Consent Information (first page)

Thank you in your interest in this survey

The purpose of this study is to identify what different animals and other critters people are familiar with.

By clicking the NEXT button below, you are acknowledging that you understand this project is research, your responses are confidential, your participation is voluntary, and that you will incur no penalty if you refuse to participate or withdraw. You also acknowledge that you have read and understand this consent form and willingly agree to participate in this research under the terms described, that there is no risks associated with taking part in this survey. Lastly, you are confirming that you are at least eighteen (18) years of age.

We would like to remind you that you must complete the entire survey to receive your incentive. You can only complete this survey once to receive payment. Failure to complete the full survey or failing an attention check will results in survey termination, your results will be deleted, and you will not be paid. Completing the survey will take no more than 25 minutes.

If you have any questions about the survey, please contact Robert Bixler (rbixler@clemson.edu) or Nathan Shipley (nshiple@clemson.edu). If you have any questions or concerns about your rights in this research study, please contact the Clemson University Office of Research Compliance (ORC) irb@clemson.edu.

Please click “Next” to begin.

1. How well do you know the animal above?

(Please chose one response)

- ❍ Not at all familiar
- ❍ Slightly familiar
- ❍ Somewhat familiar
- ❍ Moderately familiar
- ❍ Extremely familiar

2. See How often do you see the animal above?

(Please chose one response)

- ❍ Have never seen
- ❍ Have seen before on TV, in movies, or other media
- ❍ Have seen before in a zoo or in a cage
- ❍ Have seen before around or in my home
- ❍ I see it all the time

3. What do you call the animal above?

(Please type in the name that you call the animal. Be as specific as possible. If you are unsure please respond with your best guess. If you don't know then please leave this question blank)

____

4. Please rate how each of the following statements describes you.

	strongly disagree	moderately disagree	slightly disagree	neither agree nor disagree	slightly agree	moderately agree	strongly agree
My life is determined by my own actions.	❍	❍	❍	❍	❍	❍	❍
I feel like what happens in my life is mostly determined by powerful people.	❍	❍	❍	❍	❍	❍	❍
I am usually able to protect my personal interests.	❍	❍	❍	❍	❍	❍	❍
Often there is no chance of protecting my personal interests from bad luck happenings.	❍	❍	❍	❍	❍	❍	❍
My life is chiefly controlled by powerful others.	❍	❍	❍	❍	❍	❍	❍
When I get what I want, it's usually because I'm lucky.	❍	❍	❍	❍	❍	❍	❍
To a great extent, my life is controlled by accidental happenings.	❍	❍	❍	❍	❍	❍	❍
I can pretty much determine what will happen in my life.	❍	❍	❍	❍	❍	❍	❍
People like myself have very little chance of protecting our personal interests where they conflict with those of strong pressure groups	❍	❍	❍	❍	❍	❍	❍

5. Imagine that you will spend three weeks living like the early settlers lived, riding in a horse drawn wagon, cooking over an open fire, and sleeping outside on the ground. Below is a list of modern conveniences that you will not have during your trip. Please describe how much you would miss each convenience.

	Would not miss	Miss a little	Miss somewhat	Miss a lot	Can't live without
sleeping indoors	❍	❍	❍	❍	❍
bathtub or shower	❍	❍	❍	❍	❍
flush toilet	❍	❍	❍	❍	❍
television	❍	❍	❍	❍	❍
insect repellent	❍	❍	❍	❍	❍
telephone	❍	❍	❍	❍	❍
running water	❍	❍	❍	❍	❍
flashlight	❍	❍	❍	❍	❍

6. Did you ever make an insect collection in school or college?

❍ No
❍ Yes

7. Did you ever take an entomology course in school or college?

❍ No
❍ Yes

8. Do you consider yourself to be an "outdoorsy" person?

❍ Definitely not
❍ Probably not
❍ Maybe not
❍ Might or might not
❍ Maybe yes
❍ Probably yes
❍ Definitely yes

9. List all the different ways that you have learned about insects and other bugs. (Where/How)

____

10. What is your year of birth?

____

11. What is the highest level of school you have completed or the highest degree you have received?

- ❍ Less than high school degree
- ❍ High school graduate (high school diploma or equivalent including GED)
- ❍ Some college but no degree
- ❍ Associate degree in college (2-year)
- ❍ Bachelor's degree in college (4-year)
- ❍ Master's degree
- ❍ Doctoral degree
- ❍ Professional degree (JD, MD)

12. Choose one or more races that you consider yourself to be:

- ❑ White
- ❑ Black or African American
- ❑ American Indian or Alaska Native
- ❑ Asian
- ❑ Native Hawaiian or Pacific Islander
- ❑ Other ____________________

13. What is your sex?

- ❍ Male
- ❍ Female

Appendix C

Study 1 Descriptive Data

Table C.1

Demographic data for familiarity with bugs (Study 1, n = 216)

		Percent %	Mean	Standard deviation
Gender	Male	50.5		
	Female	49.5		
Highest level of education	High school	13.9		
	Some college but no degree	28.7		
	Associate	11.1		
	Bachelor	36.6		
	Master	6.5		
	Doctoral	2.3		
	Professional	0.9		
Ethnicity	White	80.5		
	African American	7.2		
	American India	3.6		
	Asian	7.3		
	Hispanic	1.4		
Ever made an insect collection	Yes	18.1		
	No	81.9		
Ever taken an entomology course in school	Yes	15.3		
	No	84.7		
Age			35.26	10.54
Consider yourself to be an "outdoorsy" person[a]			3.84	1.94

[a]was measured on a 1 to 7 scale, with 7 being “Definitely yes”

Table C.2

Rank order for mean response to items on the desire for modern comforts scale (n = 216)

	Mean[a]	Standard Deviation
running water	3.89	.98
bathtub or shower	3.75	1.04
flush toilet	3.45	1.17
sleeping indoors	3.39	1.10
Flashlight	3.34	1.06
insect repellent	3.34	1.22
Telephone	2.61	1.27
Television	2.51	1.22

[a]Measured on a 1-5 scale, with 5 being "Can't live without"

Appendix D

Study 2 Descriptive Data

Table D.1

Most common terms used to describe bugs (n = 15)

	Count	Percentage of Bugs Described with	Bugs Referenced Most[a]	Example Descriptions
color	116	68.9%	Milkweed bug (12), Shiny Flea Beetle (9), Emerald Ash Borer (8), Red-banded Leafhopper (8)	interesting color, weird color, orange coloration, pretty colors
eyes	49	46.7%	Sand Wasp (7), Eyed-click Beetle (7), Cicada (6)	eyes are big, big red eyes, big eyes, eye spots
cool	33	46.7%	Monkey Slug Caterpillar (3), Orb Weaver (3), Scorpion (3), Red-banded Leafhopper (3)	very cool, shape is cool, color is cool
wing	33	22.2%	Lacewing (7), Dobsonfly (5)	huge wings, clear wings
head	31	33.3%	Scorpionfly (5), Robber Fly (4), Termite (4)	head stands out, big head
stinger	29	17.8%	Ichneumon Wasp (9), Scorpion (5)	long stinger, stinger sticks out
legs	20	22.2%	Grasshopper (5), Millipede (4)	cricket legs, many legs

[a]Number of times the descriptive term was used to describe each bug, max of 15.

Table D.1 *continued*

Most common terms used to describe bugs (n = 15)

	Count	Percentage of Bugs Described with	Bugs Referenced Most[a]	Example Descriptions
horns	19	11.1%	Goliath Beetle (8), Hickory Horned Devil (5)	horn, big horn, horn on head, horns look dangerous
pretty	17	24.4%	Lacewing (4), Red-banded Leafhopper (3)	color looks pretty, pretty color
tail	17	13.3%	Scorpionfly (4), Pelecinid Wasp (4), Dragonfly (4)	long tail, creepy tail, stinger tail, scorpion tail
dangerous	16	26.7%	Earwig (3), Hickory Horned Devil (2), Velvet Ant (2)	looks dangerous, color is cool but looks dangerous
fuzzy	16	17.8%	Antlion (4), Sand Wasp (3)	looks fuzzy, fuzzy body
weird	15	28.9%	Monkey Slug Caterpillar (2), Milkweed Bug (2)	weird looking, weird color
cute	14	20.0%	Two-striped Planthopper (3), Saddleback (2), Weevil (2)	looks cute
shape	13	20.0%	Two-striped Planthopper (3), Orb Weaver (2), Pelecinid Wasp (2)	body shape, shape is cool, shape is bad

[a]Number of times the descriptive term was used to describe each bug, max of 15.

Table D.2

Most commonly used terms to describe each bug used in Study 2 (n = 15)

	Term	Count	Term	Count	Term	Count	Term	Count	Term	Count
antlion	sand	5	fuzzy	4	claws	2	color	2	bites	1
butterfly	eye/dots	10	moth	4	wing	3	color	2	boring	1
cactus bug	color	4	eyes	3	boring	2	head	2	cockroach	1
cicada	eyes	6	wings	4	fat	2	red	2	creepy	1
dobsonfly	dragonf ly	6	wings	5	cool	1	creepy	1	horns	1
dragonfly	tail	4	wings	4	eyes	2	ugly	2	fly	1
earwig	dangero us	3	bad	2	pinchers	2	boring	1	cockroach	1
emerald	color	8	shiny	3	eyes	2	green	2	pretty	2
eyed click beetle	eye	7	color	4	spots	4	pattern	2	texture	1
fly mimic	color	5	bee	4	yellow	4	stinger	2	black	1
giant water bug	arms	3	pincers	3	gross	2	stinger	2	cockroach	2
shiny flea beetle	color	9	red	4	shiny	3	bright	1	interesting	1
goliath beetle	horn	8	big	4	beetle	2	claw	2	fuzzy	2
monkey slug caterpillar	pink	4	cool	3	weird	2	fluffy	1	caterpillar	1
hickory horned devil	horns	5	spikes	5	caterpill ar	2	dangerous	2	alien	1
ichneumon wasp	stinger	10	tail	3	color	1	dangerous	1	wasp	1
katydid	leaf	7	green	3	color	2	cool	2	pretty	1
lacewing	wings	7	pretty	4	color	3	cool	2	clear	1
two-striped planthopper	leaf	5	color	4	cute	3	green	3	shape	3
long horned beetle	color	5	yellow	4	cricket	3	grasshopp er	3	red	2
mantidfly	wasp	6	mantis	4	arms	2	eye	2	stinger	2
milkweed bug	color	12	orange	2	weird	2	patterns	1	tiger	1
millipede	legs	4	red	3	armor	1	dangerous	1	weird	1
moth	color	5	antenna	3	red	2	wasp	2	wings	2
orb weaver	cool	3	shape	2	spider	2	pattern	1	spikes	1
pelecinid wasp	stinger	4	tail	4	scorpion	3	scary	2	shape	2
pill bug	armor	3	cute	2	shell	2	plates	1	Jurassic	1
plant bug	color	5	red	3	antenna	2	dangerous	1	cockroach	1
praying mantis	color	4	arms	3	mantis	2	shape	1	distinct	1
robber fly	head	4	bee	2	eyes	2	stinger	2	eww	1
saddleback	spikes	3	cactus	2	color	2	cute	2	hairs	2
sand wasp	eyes	7	color	5	body	3	fuzzy	3	bee	2

Table D.2 *continued*

Most commonly used terms to describe each bug used in Study 2 (n = 15)

	Term	Count	Term	Count	Term	Count	Term	Count	Term	Count
scorpion	stinger	6	cool	3	bad	1	tail	1	hurt	1
scorpionfly	beak	5	head	5	scorpion	5	stinger	4	tail	4
sharpshooter	blue	5	color	5	wings	4	alien	2	eye	2
spider	fangs	3	scary	2	eww	2	spider	2	bad	1
stag beetle	claws	5	horns	4	color	1	scary	1	red	1
termite	head	4	gross	2	eww	2	color	1	nasty	1
tiger beetle	color	5	green	2	legs	2	blue	1	eyes	1
toothpick grasshopper	legs	5	color	1	cricket	1	eww	1	head	1
red-banded leafhopper	color	8	cool	3	pretty	3	friendly	1	awesome	1
velvet ant	color	5	antenna	4	furry	3	dangerous	2	fuzzy	2
weevil	long nose	4	mouth	3	cute	2	fuzzy	2	bites	1
wheel bug	color	3	bad	1	eww	1	rock	1	spikes	1
whip scorpion	legs	3	dangerous	2	creepy	1	claws	1	ugly	1

Appendix E

<u>Study 3 Survey Questions</u>

Consent Information (first page)

Thank you for your interest in this survey

The purpose of this study is to identify general reactions to images of different animals and other critters.

By clicking the NEXT button below, you are acknowledging that you understand this project is research, your responses are confidential, your participation is voluntary, and that you will incur no penalty if you refuse to participate or withdraw. You also acknowledge that you have read and understand this consent form and willingly agree to participate in this research under the terms described, that there are no risks associated with taking part in this survey. Lastly, you are confirming that you are at least eighteen (18) years of age.

We would like to remind you that you must complete the entire survey to receive your incentive. You can only complete this survey once to receive payment. Failure to complete the full survey or failing an attention check will results in survey termination, your results will be deleted, and you will not be paid. Completing the survey will take no more than 35 minutes.

If you have any questions about the survey, please contact Robert Bixler (rbixler@clemson.edu) or Nathan Shipley (nshiple@clemson.edu). If you have any questions or concerns about your rights in this research study, please contact the Clemson University Office of Research Compliance (ORC) irb@clemson.edu.

Please click “Next” to begin.

1. The animal above is:
- Very Interesting
- Interesting
- Slightly Interesting
- Neither Interesting or Uninteresting
- Slightly Uninteresting
- Uninteresting
- Very Uninteresting

2. How interested would you be in learning more about this animal?
- Not at all interested
- Slightly interested
- Somewhat Interested
- Moderately Interested
- Extremely interested

3. The animal above is
- Very Attractive
- Attractive
- Slightly Attractive
- Neither Attractive or Unattractive
- Slightly Unattractive
- Unattractive
- Very Unattractive

4. How much do you know about this animal?
- Not at all familiar
- Slightly familiar
- Somewhat familiar
- Moderately familiar
- Extremely familiar

5. In terms of your personal safety, this animal seems:
- Very Harmful
- Harmful
- Slightly Harmful
- Neither Harmful or Not Harmful
- Slightly Not Harmful
- Not Harmful
- Very Not Harmful

6. Would you be willing to hold the animal above in your hand?
- Not at all willing
- Slightly willing
- Somewhat willing
- Very willing
- Extremely willing

7. Do the following statements describe you? Please select true or false

	False	True
I might be willing to try eating monkey meat, under some circumstances	❍	❍
It would bother me to see a rat run across my path in a park	❍	❍
Seeing a cockroach in someone else's house doesn't bother me	❍	❍
It bothers me to hear someone clear a throat full of mucus	❍	❍
If I see someone vomit, it makes me sick to my stomach	❍	❍
It would bother me to be in a science class, and see a human hand preserved in a jar	❍	❍
It would not upset me at all to watch a person with a glass eye take the eye out of the socket	❍	❍
It would bother me tremendously to touch a dead body	❍	❍
I would go out of my way to avoid walking through a graveyard	❍	❍
I never let any part of my body touch the toilet seat in a public washroom	❍	❍
I probably would not go to my favorite restaurant if I found out that the cook had a cold	❍	❍
Even if I was hungry, I would not drink a bowl of my favorite soup it if had been stirred with a used but thoroughly washed flyswatter	❍	❍
It would bother me to sleep in a nice hotel room if I knew that a man had died of a heart attack in that room the night before	❍	❍

8. Please rate how disgusting you would find the following experiences.

	Not	Slightly	Somewhat	Moderately	Extremely
If you see someone put ketchup on vanilla ice cream and eat it	❍	❍	❍	❍	❍
You are about to drink a glass of milk when you smell that it is spoiled	❍	❍	❍	❍	❍
You see maggots on a piece of meat in an outdoor garbage pail	❍	❍	❍	❍	❍
You are walking barefoot on concrete and step on an earthworm	❍	❍	❍	❍	❍
While you are walking through a tunnel under a railroad track, you smell urine	❍	❍	❍	❍	❍
You see a man with his intestines exposed after an accident	❍	❍	❍	❍	❍
Your friend's pet cat dies and you have to pick up the dead body with your bare hands	❍	❍	❍	❍	❍
You accidentally touch the ashes of a person who has been cremated	❍	❍	❍	❍	❍
You take a sip of soda and realize that you drank from the glass that an acquaintance of yours had been drinking from	❍	❍	❍	❍	❍
You discover that a friend of yours changes underwear only once a week	❍	❍	❍	❍	❍
A friend offers you a piece of chocolate shaped like dog-doo	❍	❍	❍	❍	❍
As part of a sex education class, you are required to inflate a new lubricated condom, using your mouth	❍	❍	❍	❍	❍

9. How accurately does each sentence below describe you? Check one answer for each item.

	Not at all (1)	(2)	(3)	Somewhat (4)	(5)	(6)	Very Much (7)
Members of my peer group respect and admire me.	❍	❍	❍	❍	❍	❍	❍
Members of my peer group do NOT want to be like me.	❍	❍	❍	❍	❍	❍	❍
I enjoy having control over others.	❍	❍	❍	❍	❍	❍	❍
Others always expect me to be successful.	❍	❍	❍	❍	❍	❍	❍
I often try to get my own way regardless of what others may want.	❍	❍	❍	❍	❍	❍	❍
Others do NOT value my opinion.	❍	❍	❍	❍	❍	❍	❍
I am willing to use aggressive tactics to get my way.	❍	❍	❍	❍	❍	❍	❍
I am held in high esteem by those I know.	❍	❍	❍	❍	❍	❍	❍
I try to control others rather than permit them to control me.	❍	❍	❍	❍	❍	❍	❍
I do NOT have a forceful or dominant personality.	❍	❍	❍	❍	❍	❍	❍
Others know it is better to let me have my way.	❍	❍	❍	❍	❍	❍	❍
I do NOT enjoy having authority over other people.	❍	❍	❍	❍	❍	❍	❍
My unique talents and abilities are recognized by others.	❍	❍	❍	❍	❍	❍	❍
I am considered an expert on some matters by others.	❍	❍	❍	❍	❍	❍	❍
Others seek my advice on a variety of matters.	❍	❍	❍	❍	❍	❍	❍
Some people are afraid of me.	❍	❍	❍	❍	❍	❍	❍
Others do NOT enjoy hanging out with me.	❍	❍	❍	❍	❍	❍	❍

10. How accurately do these statements describe the way you generally feel and behave? Check one answer for each item.

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
I actively seek as much information as I can in new situations	❍	❍	❍	❍	❍
I am the type of person who really enjoys the uncertainty of everyday life	❍	❍	❍	❍	❍
I am at my best when doing something that is complex or challenging	❍	❍	❍	❍	❍
Everywhere I go, I am out looking for new things or experiences	❍	❍	❍	❍	❍
I view challenging situations as an opportunity to grow and learn	❍	❍	❍	❍	❍
I like to do things that are a little frightening	❍	❍	❍	❍	❍
I am always looking for experiences that challenge how I think about myself and the world	❍	❍	❍	❍	❍
I prefer jobs that are excitingly unpredictable	❍	❍	❍	❍	❍
I frequently seek out opportunities to challenge myself and grow as a person	❍	❍	❍	❍	❍
I am the kind of person who embraces unfamiliar people, events, and places	❍	❍	❍	❍	❍

11. Please rate your level of Interest in each of the following activities. Then please indicate approximately how many times you participated in the activity during the last 12 months.

	Interest						
	Not at all Interested	Low Interest	Slightly Interested	Neutral Interest	Somewhat Interested	Very Interested	Extremely Interested
Mountain Biking	❍	❍	❍	❍	❍	❍	❍
Rock Climbing	❍	❍	❍	❍	❍	❍	❍
Backpacking or Hiking	❍	❍	❍	❍	❍	❍	❍
Canoeing or Kayaking	❍	❍	❍	❍	❍	❍	❍
Hunting	❍	❍	❍	❍	❍	❍	❍
Watching Birds at a Feeder	❍	❍	❍	❍	❍	❍	❍
Bird Watching with Binoculars away from home	❍	❍	❍	❍	❍	❍	❍
Tent Camping	❍	❍	❍	❍	❍	❍	❍
Fishing	❍	❍	❍	❍	❍	❍	❍
Golfing	❍	❍	❍	❍	❍	❍	❍
Vegetable Gardening	❍	❍	❍	❍	❍	❍	❍
Flower Gardening	❍	❍	❍	❍	❍	❍	❍
Playing Video Games	❍	❍	❍	❍	❍	❍	❍
Running or Jogging	❍	❍	❍	❍	❍	❍	❍
Reading Non-fiction Books	❍	❍	❍	❍	❍	❍	❍
Reading Fiction Books	❍	❍	❍	❍	❍	❍	❍

12. Did you ever make an insect collection?
(Select all that apply)
- ❑ Yes - In College
- ❑ Yes - In High School
- ❑ Yes- In Elementary School
- ❑ Yes - Outside of School
- ❑ Never Have

13. Did you ever take an entomology course?
(Select all that apply)
- ❑ Yes - In College
- ❑ Yes - In High School
- ❑ Never Have

14. Are you the parent or guardian of a child under the age of 12?
- ❍ Yes
- ❍ No

15. What is your year of birth?

16. What is the highest level of school you have completed?
- ❍ Less than high school degree
- ❍ High school graduate (high school diploma or equivalent including GED)
- ❍ Some college but no degree
- ❍ Associate degree in college (2-year)
- ❍ Bachelor's degree in college (4-year)
- ❍ Master's degree
- ❍ Doctoral degree
- ❍ Professional degree (JD, MD)

17. Choose one or more races that you consider yourself to be:
- ❑ White
- ❑ Black or African American
- ❑ American Indian or Alaska Native
- ❑ Asian
- ❑ Native Hawaiian or Pacific Islander
- ❑ Hispanic or Latino
- ❑ Other _____________________

18. What is your sex?
- ❍ Male
- ❍ Female

19. What is your Zip code?

20. Do you consider yourself to be an "Outdoorsy" person?
- ❍ Definitely not
- ❍ Probably not
- ❍ Maybe not
- ❍ Neutral
- ❍ Maybe yes
- ❍ Probably yes
- ❍ Definitely Yes

Appendix F

Study 3 Descriptive Data

Table F.1

Demographic data for perceptions of bugs (Study 3, n = 308)

		Percent %	Mean	Standard deviation
Gender	Male	48.4		
	Female	51.6		
Highest level of education	Less than high school degree	0.6		
	High school	17.5		
	Some college but no degree	24.4		
	Associate	16.2		
	Bachelor	32.8		
	Master	6.8		
	Doctoral	1.3		
	Professional	0.3		
Ethnicity	White	82.1		
	African American	8.8		
	American India	1.3		
	Asian	0.3		
	Hispanic	7.5		
Ever make an insect collection	Yes	22.4		
	No	77.6		
Ever take an entomology course	Yes	5.8		
	No	94.2		
Age			36.72	10.99
Consider yourself to be "outdoorsy"[a]			4.3	2.05

[a]was measured on a 1 to 7 scale, with 7 being “Definitely yes”

Table F.2

Rank order for mean response to items on the disgust sensitivity scale

	Mean[a]	Standard Deviation
You see a man with his intestines exposed after an accident	.81	.26
Seeing a cockroach in someone else's house doesn't bother me	.69	.46
Even if I was hungry, I would not drink a bowl of my favorite soup it if had been stirred with a used but thoroughly washed flyswatter	.68	.47
I might be willing to try eating monkey meat, under some circumstances	.66	.47
You see maggots on a piece of meat in an outdoor garbage pail	.66	.30
I probably would not go to my favorite restaurant if I found out that the cook had a cold	.65	.48
You discover that a friend of yours changes underwear only once a week	.64	.30
If I see someone vomit, it makes me sick to my stomach	.61	.50
You are about to drink a glass of milk when you smell that it is spoiled	.61	.29
It would not upset me at all to watch a person with a glass eye take the eye out of the socket	.58	.49
Your friend's pet cat dies and you have to pick up the dead body with your bare hands	.57	.34
It would bother me tremendously to touch a dead body	.56	50
It would bother me to sleep in a nice hotel room if I knew that a man had died of a heart attack in that room the night before	.56	.50
It bothers me to hear someone clear a throat full of mucus	.52	.50
You are walking barefoot on concrete and step on an earthworm	.48	.32
While you are walking through a tunnel under a railroad track, you smell urine	.48	.28
It would bother me to be in a science class, and see a human hand preserved in a jar	.44	.50
I never let any part of my body touch the toilet seat in a public washroom	.43	.50
If you see someone put ketchup on vanilla ice cream and eat it	.40	.33
It would bother me to see a rat run across my path in a park	.39	.49
You accidentally touch the ashes of a person who has been cremated	.39	.34
As part of a sex education class, you are required to inflate a new lubricated condom, using your mouth	.31	.36
A friend offers you a piece of chocolate shaped like dog-doo	.31	.31
I would go out of my way to avoid walking through a graveyard	.28	.45
You take a sip of soda and realize that you drank from the glass that an acquaintance of yours had been drinking from	.27	.28

[a]Measured on a 0-1 scale, with 1 being "Extremely Disgusting"

Table F.3

Rank order for mean response to items on the dominance and prestige scale

	Mean[a]	Standard Deviation
Others do NOT enjoy hanging out with me.	5.93	1.27
Others do NOT value my opinion.	5.80	1.38
Members of my peer group do NOT want to be like me.	5.30	1.50
Others seek my advice on a variety of matters.	4.47	1.56
Members of my peer group respect and admire me.	4.46	1.46
My unique talents and abilities are recognized by others.	4.43	1.50
I am considered an expert on some matters by others.	4.32	1.65
I am held in high esteem by those I know.	4.27	1.46
Others always expect me to be successful.	4.16	1.62
I do NOT enjoy having authority over other people.	3.67	1.93
I do NOT have a forceful or dominant personality.	3.54	1.93
I often try to get my own way regardless of what others may want.	2.86	1.61
I try to control others rather than permit them to control me.	2.72	1.67
I enjoy having control over others.	2.65	1.63
I am willing to use aggressive tactics to get my way.	2.60	1.65
Others know it is better to let me have my way.	2.58	1.53
Some people are afraid of me.	2.20	1.51

[a]Measured on a 1-7 scale, with 7 being "Very Much"

Appendix G

Study 4 Informed Consent Letter

Information Concerning Participation in a Research Study
Clemson University

Human Response to Images of Animals

Description of the research and your participation
You are invited to participate in a research study to analyze how humans perceive different animals. The project was designed by Nathan Shipley and Robert Bixler. The study uses eye tracking technology. Eye tracking is the use of hardware and software to track where a computer user is looking on a computer screen. Your participation will involve viewing different images of animals.

The amount of time required for your participation will be no more than 30 minutes.

Risks and discomforts
There are certain discomforts that you might experience if you take part in this research. Discomforts include feelings of eye-strain and other discomforts from using the eye-tracking equipment. The experiment does not require anything more than watching a typical computer monitor. No gadgets are attached to your body. You will be allowed to take breaks to rest when needed, and you may quit the research at any time without penalty.

Although unlikely, if you happen to feel uncomfortable in any way (dizzy, lightheaded, or nauseous) move your eyes away from the eye tracker and notify the research assistant immediately. If you continue to feel discomfort after the study, please contact Redfern Health Center at 656- 2451.

Potential benefits
There are no known benefits to you from your participation in this research. The societal benefit will be an improved understanding of educational strategies focused on wildlife. You will receive a payment of $20 in the form of a VISA card if you complete the entire study.

Protection of confidentiality
We will protect your privacy. Your legal name will not be associated with the answers you provide. Hence, your identity reported in any publication that might result from this study, nor will it be stored in any records we keep. In rare cases, a research study will be evaluated by an oversight agency, such as the Clemson University Institutional Review Board or the federal Office for Human Research Protections, which would require that we share the information we collect from you. If this happens, the information would only be used to determine if we conducted this study properly and adequately protected your rights as a participant.

Voluntary participation
Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized should you decide not to participate or to withdraw from this study. If you choose to stop taking part in this study, the information you have already provided will be kept in a confidential manner.

Contact information
If you have any questions or concerns about this study or if any problems arise, please contact Dr. Robert Bixler at (864) 656-4849 or Nathan Shipley at Clemson University at (913) 233-6394. If you have any questions or concerns about your rights as a research participant, please contact the Clemson University Office of Research Compliance at (864) 656-0636

CLEMSON
RESEARCH COMPLIANCE

IRB Number: IRB2017-009
Approved: 2/9/2017
Expiration: 2/8/2018

Appendix H

Study 4 Survey Questions

1. Do the following statements describe you? Please select true or false

	False	True
I might be willing to try eating monkey meat, under some circumstances	❍	❍
It would bother me to see a rat run across my path in a park	❍	❍
Seeing a cockroach in someone else’s house doesn’t bother me	❍	❍
It bothers me to hear someone clear a throat full of mucus	❍	❍
If I see someone vomit, it makes me sick to my stomach	❍	❍
It would bother me to be in a science class, and see a human hand preserved in a jar	❍	❍
It would not upset me at all to watch a person with a glass eye take the eye out of the socket	❍	❍
It would bother me tremendously to touch a dead body	❍	❍
I would go out of my way to avoid walking through a graveyard	❍	❍
I never let any part of my body touch the toilet seat in a public washroom	❍	❍
I probably would not go to my favorite restaurant if I found out that the cook had a cold	❍	❍
Even if I was hungry, I would not drink a bowl of my favorite soup it if had been stirred with a used but thoroughly washed flyswatter	❍	❍
It would bother me to sleep in a nice hotel room if I knew that a man had died of a heart attack in that room the night before	❍	❍

2. Please rate how disgusting you would find the following experiences.

	Not	Slightly	Somewhat	Moderately	Extremely
If you see someone put ketchup on vanilla ice cream and eat it	❍	❍	❍	❍	❍
You are about to drink a glass of milk when you smell that it is spoiled	❍	❍	❍	❍	❍
You see maggots on a piece of meat in an outdoor garbage pail	❍	❍	❍	❍	❍
You are walking barefoot on concrete and step on an earthworm	❍	❍	❍	❍	❍
While you are walking through a tunnel under a railroad track, you smell urine	❍	❍	❍	❍	❍
You see a man with his intestines exposed after an accident	❍	❍	❍	❍	❍
Your friend's pet cat dies and you have to pick up the dead body with your bare hands	❍	❍	❍	❍	❍
You accidentally touch the ashes of a person who has been cremated	❍	❍	❍	❍	❍
You take a sip of soda and realize that you drank from the glass that an acquaintance of yours had been drinking from	❍	❍	❍	❍	❍
You discover that a friend of yours changes underwear only once a week	❍	❍	❍	❍	❍
A friend offers you a piece of chocolate shaped like dog-doo	❍	❍	❍	❍	❍
As part of a sex education class, you are required to inflate a new lubricated condom, using your mouth	❍	❍	❍	❍	❍

3. How well do the following statements describe your personality? I see myself as someone who...

	Disagree strongly	Disagree a little	Neither agree nor disagree	Agree a little	Agree strongly
...is reserved	❍	❍	❍	❍	❍
...is generally trusting	❍	❍	❍	❍	❍
...tends to be lazy	❍	❍	❍	❍	❍
...is relaxed, handles stress well	❍	❍	❍	❍	❍
...has few artistic interests	❍	❍	❍	❍	❍
...is outgoing, sociable	❍	❍	❍	❍	❍
...tends to find fault with others	❍	❍	❍	❍	❍
...does a thorough job	❍	❍	❍	❍	❍
...gets nervous easily	❍	❍	❍	❍	❍
...has an active imagination	❍	❍	❍	❍	❍

4. Please check all the animals that you have ever owned as a pet(If an animal is not listed, please enter in the black space)

❑ Dog (1)
❑ Cat (2)
❑ Fish (3)
❑ Bird (4)
❑ Rabbit (5)
❑ Other (6) ____________________

5. Did you ever make an insect collection?(Select all that apply)

❑ Yes - In College (1)
❑ Yes - In High School (2)
❑ Yes- In Elementary School (3)
❑ Yes - Outside of School (4)
❑ Never Have (5)

6. Did you ever take an entomology course?(Select all that apply)

❑ Yes - In College (1)
❑ Yes - In High School (2)
❑ Never Have (3)

7. Do you consider yourself to be an "Outdoorsy" person?
- ❍ Definitely not (1)
- ❍ Probably not (2)
- ❍ Maybe not (3)
- ❍ Neutral (4)
- ❍ Maybe yes (5)
- ❍ Probably yes (6)
- ❍ Definitely Yes (7)

8. What is your year of birth?

9. Choose one or more races that you consider yourself to be:
- ❑ White (1)
- ❑ Black or African American (2)
- ❑ American Indian or Alaska Native (3)
- ❑ Asian (4)
- ❑ Native Hawaiian or Pacific Islander (5)
- ❑ Hispanic or Latino (6)
- ❑ Other (7) ____________________

10. What is your sex?
- ❍ Male (1)
- ❍ Female (2)

11. What year in college are you?
- ❍ Freshman (1)
- ❍ Sophomore (2)
- ❍ Junior (3)
- ❍ Senior (4)
- ❍ Graduate (5)

12. What is your major?

Appendix I

Study 4 Instructional Set for Participants

Experimenter:

"Thank you for agreeing to participate in this study. We will be asking you to view several images of different animals.

"Let's begin. Please authorize your participation by reading this informational letter" *Experimenter hands* ***information letter*** *to participant.*

"Do you have any questions?" *Experimenter answers any questions that the participant has.*

"Please be seated in front of the computer screen and the eye tracker. We will now perform a series of steps to adjust the tracker to your eyes. First, we will need to adjust the eye tracker position so that it is centered on your pupils." *Experimenter adjusts eye tracker position.*

"Now, please look straight ahead at the calibration utility on the computer screen, and maintain your position. I will be asking you to look at nine points on the screen. Please follow the points as they move, moving only your eyes." *Experimenter initiates calibration. If the calibration result is unsatisfactory, the above procedure is repeated.*

"To start this study, I am going to have you view a trial image to get you familiar with the study procedure. All I want you to do is view the image on the screen naturally, as if you were looking at a picture in a magazine." *Experimenter initiates trial image.*

"Thank you. There are two sections to this study, with a short break in-between. We will now begin the first section. I will explain this section now and the second section after the break. For the first section, your task is to view two images of different animals and tell me which of the two you would like to learn more about. On the computer screen, a crosshair will appear. Please focus on the crosshair. The program will automatically advance to the animal images. While these images are up, please view them as if you were just looking at pictures in a magazine. After a few moments, the image will disappear. When the image disappears, please tell me if you would like to learn more about the animal on the left or the right. After, the crosshair will appear again and this processes will repeat until we are done. Do you have any questions?" *Experimenter answers any questions that the participant has.*

-Experiment is conducted, experimenter records participant response on the data collection tool, when the task ends the experimenter instructs the participant they can take a short break. While doing so, the participant will be asked to respond to a brief online survey-

-Following the survey, the second task will begin-

"For the second task, you are to look forward at the monitor as before. This time, you will follow the same procedure, however there will only be one animal. When the animal disappears, you are to then rate the animal on 4 traits. These traits will appear on the screen so you don't have to remember. You will rate the image on its overall attractiveness, perceived harmfulness to you, how interested you are in learning more about it, and how willing you would be to hold it in your hand. When the questions appear on the screen, please verbally tell me your responses. Do you have any questions?" *Experimenter answers any questions that the participant has.*

-Experimenter repeats the calibration done before the first task, initiatives the experiment and is conducted, experimenter records participant response-

"This concludes the experiment. Thank you for your participation. Please feel free to contact us if you have any additional questions." *Experimenter concludes the study by giving the participant a Visa Gift Card*

Appendix J

Study 4 Descriptive Data

Table J.1

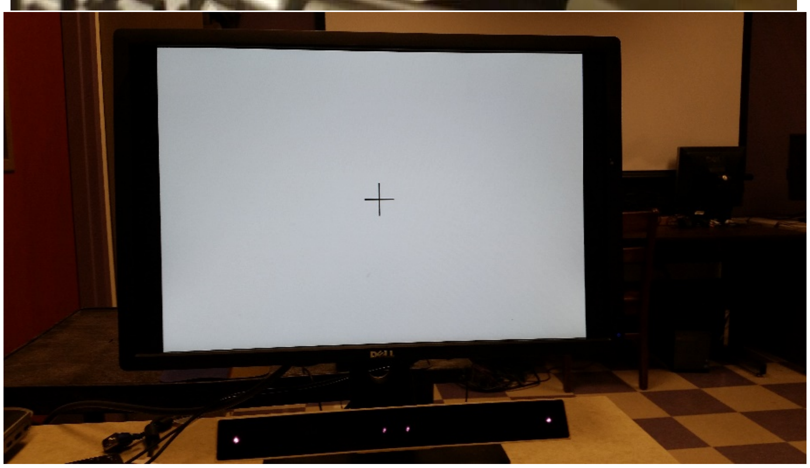
Demographic data for eye tracking (Study 4, n = 48)

		Percent %	Mean	Standard deviation
Gender	Male	60.4		
	Female	39.6		
Year in college	Sophomore	4.2		
	Junior	10.4		
	Senior	12.5		
	Graduate	72.9		
Ethnicity	White	72.8		
	African American	4.2		
	Asian	18.8		
	Hispanic	4.2		
Ever make an insect collection	Yes	39.6		
	No	60.4		
Ever take an entomology course	Yes	22.9		
	No	77.1		
Age			28.39	6.48
Consider yourself to be "outdoorsy"[a]			5.73	1.63

[a]was measured on a 1 to 7 scale, with 7 being “Definitely yes”

Appendix K

<u>Eye Tracking Equipment Setup</u>



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