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Understanding how Preservice Teachers' Fear, Perceived Danger and Disgust Affects the Incorporation of Arachnid Information into the Elementary Science Classroom

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ABSTRACT

Arachnids are predatory arthropods that are beneficial to humans in many ways, with common examples including spiders and scorpions. Despite the importance of arachnids to global ecosystems, the fear of spiders in specific human groups is well documented. Arachnids are a very diverse class (i.e., Arachnida) encompassing eleven extant orders with over 100,000 described species but little is known about other emotions and beliefs humans have towards most other arachnid orders. Because of the importance of arachnids to global ecosystems and the services they provide to humanity, elementary children should learn about arachnids. However, prior research shows that preservice elementary teachers do not plan to include information about arachnids in their classrooms. The current study analyzed the effect a living arachnid workshop had on United States (US) kindergarten through sixth grade (K-6) preservice elementary teachers' emotions and beliefs towards living arachnids and sought to see if the arachnid workshop could reduce the participants fear, perceived danger and disgust towards arachnids and increase their likelihood of incorporating information about arachnids into their science classroom. Five living arachnids from five of the eleven extant arachnid orders were used in the study, which is the most biodiverse group of arachnids used in a study to assess the emotions and beliefs humans have toward arachnids. This study employs a longitudinal design (i.e., pretest, posttest 1 and posttest 2) with randomly assigned treatment and control groups thereby giving the researchers the ability to make casual claims and assess the effect of the intervention over a longer period of time. The treatment group exhibited a steady and maintained decrease in the levels of fear, perceived danger and disgust across the time points, while the control group exhibited little change in these responses. A positive change in the likelihood of incorporation for each of the animals across time for the treatment group was found, while the control group showed little or no change in these responses across time. Implications of the study and future research are presented that are applicable to preservice elementary teachers, university science education instructors and teacher training programs.

KEYWORDS
Arachnids, belief, danger, disgust, fear, perceived danger, preservice elementary teachers

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Introduction

Arachnids are predatory arthropods that are beneficial to humans in many ways, with common examples including spiders and scorpions. Arachnids exist in almost

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all terrestrial and semi-terrestrial ecosystems on Earth and benefit humans indirectly by decreasing the densities of arthropods (e.g., insects) in global environments. Many of these arthropod species, when present in high numbers, decrease yields in agricultural plant crops that sustain humans (Marc, Canard & Ysnel, 2009; Nyffeler & Sunderland, 2003; Pfannenstiel, 2008). Arachnids also benefit humans indirectly by eating many arthropods that can be vectors for disease in human populations (Strickman, Sithiprasasna & Southard, 1997). Furthermore, arachnids indirectly benefit humans by serving as a food sources for animals humans enjoy esthetically such as monkeys, apes and lemurs (Georgiev, Thompson, Lotana & Wrangham, 2011; Simmen, Hladik & Ramasiarisoa, 2003). Lastly, arachnids benefit humans directly by serving as a food source in human cultures such as in Cambodia where humans eat tarantulas (Yen & Ro, 2013).

Despite the importance of arachnids to global ecosystems, the fear of spiders in specific human groups is well documented (Davey, 1994; Gerdes, Uhl & Alpers, 2009). Arachnids are a very diverse class (i.e., Arachnida) encompassing eleven extant orders with over 100,000 described species (Chapman, 2005) but little is known about other emotions and beliefs humans have towards most other arachnid orders. Because of the importance of arachnids to global ecosystems and the services they provide to humanity, elementary children should learn about arachnids. However, prior research shows that preservice elementary teachers do not plan to include information about arachnids in their classrooms (Wagler, 2010; Wagler & Wagler, 2011). The current study analyzed the effect a living arachnid workshop had on United States (US) kindergarten through sixth grade (K-6) preservice elementary teachers' emotions and beliefs towards living arachnids, beyond the spider, and sought to see if the arachnid workshop could reduce the participants fear, perceived danger and disgust towards arachnids and increase their likelihood of incorporating information about arachnids into their science classroom. The variables measured were 1) human fear toward an arachnid, 2) human perceived danger toward an arachnid, 3) human disgust toward an arachnid and 4) human belief concerning the likelihood of incorporating information about an arachnid into the preservice elementary teachers' future science classroom (henceforth referred to as "likelihood of incorporation"). Five living arachnids from five of the eleven extant arachnid orders were used in the study (See Table 1 and Figure 1). This is the most biodiverse group of arachnids ever used in a study to assess the emotions and beliefs humans have toward arachnids. A thorough review of the literature shows most studies that assess human emotions toward arachnids are limited only to spiders and only assess these emotions in a cross-sectional study. This study employs a longitudinal design (i.e., pretest, posttest 1 and posttest 2) with randomly assigned treatment and control groups thereby giving the researchers the ability to make casual claims and assess the effect of the intervention over a longer period of time.

Table 1. Names and Orders of Live Arachnids used in the Study

Scientific Name	Common Name	Order
Brachypelma smithi	Mexican Red Knee Spider	Araneae
Damon diadema	Tailless Whip Scorpion	Amblypygi
Mastigoproctus giganteus	Vinegaroon	Thelyphonida
Pandinus imperator	Emperor Scorpion	Scorpiones
Vonones ornata	Ornate Harvestmen	Opiliones

Domain: Eukarya, Kingdom: Animalia, Phylum: Arthropoda, Class: Arachnida.

Photograph by Ron Wagler. The body length of the arachnid pictured is 5 centimeters.

Figure 1. One of the Living Arachnids used in the Study: Tailless Whip Scorpion (*Damon diadema*)

Theoretical Framework of the Study

Human Disgust, Fear and Perceived Danger

Disgust is defined as "a feeling of revulsion or profound disapproval aroused by something unpleasant or offensive" (Oxford Dictionaries, 2016). Fear is defined as "an unpleasant emotion caused by the belief that someone or something is dangerous, likely to cause pain, or a threat" (Oxford Dictionaries, 2016). Danger is defined as "The possibility of suffering harm or injury" (Oxford Dictionaries, 2016). It is theorized that the two human emotions of disgust and fear are protective and produce human avoidance of potentially dangerous and disease causing animals (Curtis, Aunger & Rabie, 2004; Davey, 1994; Seligman, 1971). Specific animals can evoke elevated levels of disgust, fear and perceived danger (Prokop, Uşak & Fančovičová, 2010). For example, spiders elicit significantly greater levels of disgust, fear and perceived danger in humans than beetles, bees/wasps and butterflies/moths (Gerdes, Uhl & Alpers, 2009). When humans find specific animals disgusting they can be motivated to avoid that animal (Curtis, Aunger & Rabie, 2004; Oaten, Stevenson & Case, 2009; Prugnolle, Lefevre, Renaud, Moller, Missea & Thomas, 2009). Fear can also motivate humans to avoid specific animals based on the perception that an animal is dangerous (Nesse, 1990; Ohman & Mineka, 2001; Prokop, Uşak & Fančovičová, 2010; Rachman, 2004).

Human Belief

Human belief is an estimate of the likelihood that the knowledge one has about an entity is correct or, alternatively, that an event or a state of affairs has or will occur (Eagly & Chaiken, 1998). Human belief about the future is frequently associated with human expectation (Olson, Roese & Zanna, 1996). Furthermore, human belief can be viewed as "an estimate of subjective probability, or alternatively, of the certainty that a proposition is true." (Albarracín, Johnson & Zanna, 2005, p. 274).

Literature Review

Arachnids: A Brief Overview

Arachnids are arthropods that have a segmented body, a chitinous exoskeleton and jointed appendages (Budd & Telford, 2009; Johnson, 2003). Common examples of arachnids include spiders, ticks, mites and scorpions. All arachnids have two body segments (i.e., tagma) called the cephalothorax (i.e., prosoma) and abdomen (i.e., opisthosoma) and, at some point in their development, four pairs of legs. Arachnids also have two other pairs of evolutionarily adapted appendages, the pedipalps for locomotion, feeding and/or reproduction and the chelicerae (e.g., "fangs" in spiders) for defense and feeding. Arachnids do not have antennae or wings and some are venomous (e.g., spiders and scorpions). Arachnid evolution began over 400 million years ago and continues in the estimated 200,000 to 600,000 species worldwide (Chapman, 2005).

Research addressing Arachnids and Other Arthropods in Educational Settings

Research is now presented that addresses arachnids and other arthropods in educational settings. The research studies presented in this section have not used living animals except for the Randler studies. Bjerke, Odegardstuen and Kaltenborn (1998) explored Norwegian children and adolescents degree of preference for animals. They found that the degree of preference for animals varies depending on the type of animal. The worm, spider, bee and crow were found to be the least favorite species. The cat, dog, rabbit and horse were the favorite species. Very few of the studies participants were willing to save ecologically-significant insects (i.e., ants, bees and lady beetles) from going extinct (Bjerke, Odegardstuen & Kaltenborn, 1998).

Prokop and Tunnicliffe (2008) assessed spider and bat attitudes in Slovakian children ranging in age from 10-16 years. Children had more negative attitudes toward spiders than bats with female participants having greater negativity than male participants. Irrespective of childrens' age or gender, alternative conceptions and knowledge of bats and spiders were distributed randomly (Prokop & Tunnicliffe, 2008). A moderate correlation between attitude and knowledge of bats was found. No similar tendency was found with spiders (Prokop & Tunnicliffe, 2008).

Spiders tend to elicit significantly greater fear, disgust and perceived danger among university entry-level psychology students when compared to beetles, bees/wasps and butterflies/moths (Gerdes, Uhl & Alpers, 2009). Ratings of disgust and fear of spider pictures significantly predicted the questionnaire scores for fear of spiders. Dangerousness ratings of other arthropods and spiders did not provide any predictive power. Gerdes, Uhl and Alpers (2009) results showed that the potential harmfulness of a spider cannot explain why spiders are feared so often.

Attitudes towards spiders and the level of knowledge of spiders of high school students from Slovakia and South Africa have also been compared (Prokop, Tolarovičová, Camerik & Peterková, 2010). Biology teaching in Slovakia is based on systematic zoology and botany while the South African system is based on ecosystems. A statistically significant but low correlation between knowledge and attitude was found among the Slovakian students. Based on Kellert's (1996) categories of attitude (scientistic, negativistic, naturalistic, and ecologistic), South African students had higher scores in the categories of scientistic, naturalistic and ecologistic attitudes. Prokop, Tolarovičová, Camerik and Peterková (2010) also found that Slovakian students have less fear of spiders than South African students. Further information about human attitudes toward spiders was discovered when Wagler and Wagler (2013) showed that human attitudes toward spiders are dependent on if the spider is carnivorous or herbivorous. Wagler and Wagler (2013) found preservice elementary teachers tend to have more positive attitudes toward a herbivorous spider (i.e., *Bagheera kiplingi*) than a carnivorous spider (i.e., *Phidippus audax*).

Randler, Hummel and Prokop (2012) performed living animal activities with 11-13 year old students in practical biology. They chose three unpopular animals that consisted of a mouse, a snail and a wood louse. The study had a treatment group that performed the activities and a control group that did not perform the activities. The researchers reported that fear and disgust for all three animals significantly decreased in the treatment group but fear and disgust did not decrease in the control group. Randler, Hummel and Prokop's study provided strong evidence that when 11-13 year old students performed activities with unpopular animals their levels of fear and disgust toward those animals decreased.

Situational disgust was measured during a range of educational activities that occurred during a university course (Randler, Hummel & Wüst-Ackermann, 2013). Dissection was rated to be the most disgusting, then experiments with living animals, then experiments without animals and lastly observations using a microscope were perceived as being least disgusting. Randler, Hummel and Wüst-Ackermann found that higher disgust was related to higher boredom and higher pressure and lower disgust was related to competence, well-being and high interest. Based on the findings of their study Randler, Hummel and Wüst-Ackermann concluded that there is a need to measure situational disgust in addition to survey studies. Their study also provided strong evidence that disgust can negatively affect student motivation.

Preservice Elementary Teachers' Attitudes and Beliefs toward Arachnids and Other Arthropods in Educational Settings

Because the target population for this study is preservice elementary teachers research is now presented that addresses preservice elementary teachers' attitudes and beliefs toward arachnids and other arthropods in educational settings. Research of this nature is limited. Wagler (2010) found that if a non-science major K-4 preservice elementary teacher had a positive attitude toward an animal they were much more likely to believe they would incorporate information about that animal into their future science classroom. Conversely, if a K-4 preservice elementary teacher had a negative attitude toward an animal they were much more likely to believe they would not incorporate information about that animal into their future science classroom. Based on these beliefs the science learning environment that the vast majority of the preservice elementary teachers in the study would construct for their future students would be dominated by mammals (Wagler, 2010). The learning environment would be void of any information about invertebrates (e.g., sponges, corals, worms, mollusks, insects [Excluding the butterfly], crustaceans, and arachnids), amphibians and reptiles.

K-4 preservice elementary teachers that performed educational activities with Madagascar hissing cockroaches (i.e., MHCs) had their attitudes and likelihood of incorporating information about MHCs in their future science curriculum changed in a positive way toward the Madagascar hissing cockroaches but not toward other arthropods that they did not have contact with (Wagler & Wagler, 2011). The non-contact arthropods included a millipede, centipede, butterfly, dragonfly, grasshopper, spider, lady beetle, crayfish and scorpion. This study provided strong evidence that in order to positively change preservice elementary teacher attitudes and incorporate beliefs toward a specific animal, frequent direct contact in an educational setting with that specific animal is needed (Wagler & Wagler, 2011).

Wagler and Wagler (2012) conducted a study to investigate if the external morphology of an insect had a negative effect on preservice elementary teachers' attitudes toward insects and their beliefs concerning the likelihood of incorporating information about insects into their future science classrooms. The preservice elementary teachers were shown pictures of three insects (i.e., lady beetle, butterfly or dragonfly) and were asked to rate their attitude toward the insects and beliefs concerning the likelihood of incorporating information about the insects into their future science classrooms. The treatment group was shown a picture of the larva and adult stage of the three insect while the control group was only shown the adult stage of the three insect. Unique to the study, was the finding that the external morphology of an insect was a causal factor that can negatively affect preservice elementary teachers' attitudes toward insects and beliefs concerning the likelihood of incorporating insects into future science education settings.

Wagler and Wagler (2013) explored knowledge of arthropod (i.e., insect and spider) carnivory and herbivory as possible casual factors that contribute to the negative tendencies preservice elementary teachers have toward most arthropods. The study investigated the effect knowledge of arthropod carnivory and herbivory had on preservice elementary teachers' attitudes toward that arthropod and belief concerning the likelihood of incorporating information about that specific arthropod into their future science classroom. Unique to the study was the finding that arthropod carnivory and herbivory are causal factors that strongly affect preservice elementary teachers' attitudes and beliefs toward arthropods. When the participants of the study were made aware that an arthropod they thought was a herbivore was actually a carnivore, their attitude and likelihood of incorporation significantly declined. When the participants of the study were made aware that an arthropod they thought was a carnivore was actually a herbivore, their attitude and likelihood of incorporation significantly increased.

The current research study builds upon the previous work of Wagler and Wagler by widening the scope of arthropods beyond the spider and assessing the levels of fear, disgust, perceived danger and likelihood of incorporation for a cohort of preservice elementary teachers and assessing how lasting the educational intervention is for these factors.

Methodology

Research Question

How does fear toward an arachnid, perceived danger toward an arachnid, disgust toward an arachnid and belief concerning the likelihood of incorporating information about an arachnid into the preservice elementary teachers' future science classroom change across time for the treatment and the control group?

Study Participants

The study's participants were enrolled in an elementary level science education methods course at an urban midsized US university that has a high Hispanic/Latino population. The participants were training to teach K-6 grade students (i.e., approximately 5 to 12 years of age) and were non-science majors. Table 2 presents the number of participants in the treatment and control group and their demographic information.

Table 2. Study Participants and Demographic Information

Group	Number of Participants	Gender	Ethnicity	Mean Age
Treatment	128	121 Female 7 Male	117 Hispanic/Latino 6 White 2 Black 2 Other 1 Asian	27.11
Control	128	123 Female 5 Male	119 Hispanic/Latino 8 White 1 Other	28.21

The Procedure of the Study

Pretest.

A pretest was given to all participants of the study enrolled in the elementary level science education methods course on the first day of the semester. At the time of the pretest no course information had been presented to the participants of the study. The preservice elementary teachers observed the five living arachnids (See Table 1) which had been placed in clear containers (17.5 cm dia. X 8 cm H) with clear lids. The five living arachnids used in the study were mature adults and all five were randomized. Based on this random placement, each preservice elementary teacher observed each living arachnid from an approximate distance of 60 cm for 60 seconds. The preservice elementary teachers then rated their level of perceived danger, disgust, fear (Likert scale: Not at all [1] to Extremely [5]) and likelihood of incorporation (Likert scale: Extremely Unlikely [1] to Extremely Likely [4]) for all five of the studies living arachnids. Prior peer-reviewed research studies have used Likert scales to measure disgust, perceived danger, fear and likelihood of incorporation (Gerdes, Uhl & Alpers, 2009; Prokop, Uşak & Fančovičová, 2010; Wagler, 2010; Wagler & Wagler, 2011; Wagler & Wagler, 2012; Wagler & Wagler, 2013).

The arachnid workshop and posttest 1.

Immediately after the pretest was given the treatment group participated in the arachnid workshop. The control group did not participate in the arachnid workshop and instead received introductory information about the elementary level science education methods course. No arthropod or arachnid information was presented to the participants in the control group during the entire study. Then the treatment and control group rated their level of disgust, perceived danger, fear and likelihood of incorporation for all five of the living arachnids used in the study (i.e., posttest 1).

Posttest 2.

Fifteen weeks later, at the end of the semester, the treatment and control group again rated their level of disgust, perceived danger, fear and likelihood of incorporation for all five of the living arachnids used in the study (i.e., posttest 2). No arthropod or arachnid information was presented to any participant in the control or treatment group between posttest 1 and posttest 2.

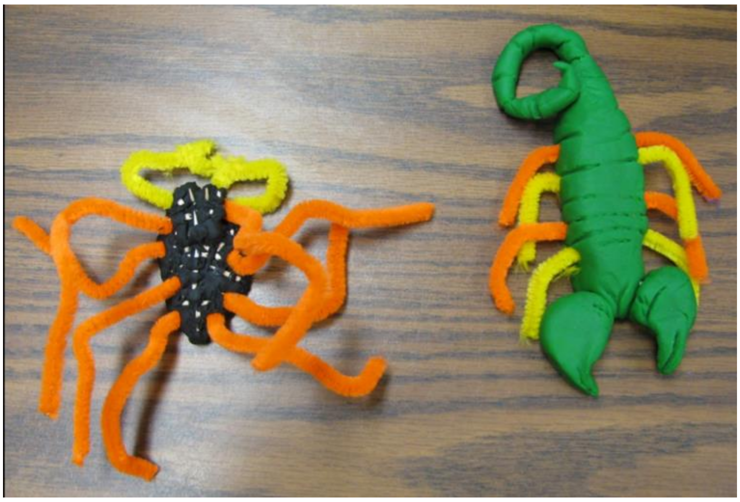
The Arachnid Workshop

An overview of the arachnid workshop.

During the arachnid workshop two arachnid activities were conducted with the treatment group. Each activity was 90 minutes long and a 10 minute break occurred between activity one and two. The arachnid activities occurred in a well-lighted room with eight round tables (106 cm dia.) of equal size. Four study participants were seated at each table. In the center of each table were placed five clear containers (17.5 cm dia. X 8 cm H) with clear lids and 1 mm holes. Each container held one of the five arachnids used in the study (see Table 1). The arachnids stayed in the containers throughout both activities. The studies participants were allowed to gently lift the containers and observe the living arachnids during both of the activities.

Arachnid activity 1: The ecological importance of the external morphology of arachnids.

Each of the preservice elementary teachers was allowed to select one of the living arachnid species and build a model of that specific arachnid species based on the arachnid's observable external morphology. The participant's model was based on the observations they made of the living arachnids at their table. The participants were allowed to build their model by selecting from supplies that consisted of colored pipe cleaners, tooth picks and colored Play-Doh (see Fig. 2).



Photograph by Ron Wagler. The length of the green scorpion is 7.5 centimeters.

Figure 2. An Example of Two Participants Arachnid Models: The Tailless Whip Scorpion (*Damon diadema*) on the Left and the Emperor Scorpion (*Pandinus imperator*) on the Right.

After all of the preservice elementary teachers constructed their models, they moved through the room and looked at all of the other models that had been built. Lastly, the facilitator of the first activity selected certain participant's models and discussed how the external morphological characteristics of each species assist that species ecological survival and reproduction. All five arachnid species were selected and discussed.

Arachnid activity 2: The ecological importance of arachnids to global ecosystems.

Each table of four preservice elementary teachers picked one of the living arachnids and constructed a food web poster (71.12 H X 55.88 cm W). The preservice elementary teachers made the food web poster by selecting from supplies that consisted of colored markers, glue sticks, colored construction paper, colored poster board, scissors and staplers. The preservice elementary teachers were told that the poster's food web must include the following components: 1) the living arachnid they had chosen; 2) plants that exist in the ecosystem the arachnid is indigenous to; 3) the sun; 4) humans; and 5) any other organisms needed to make the food web correctly. By incorporating these components the preservice elementary teachers were able to observe the movement of energy from the sun to humans, see how their chosen living arachnid was an essential part of their food web poster and also see how the arachnid was indirectly or directly beneficial to the preservice elementary teachers. Every group was also permitted to use the computers in the university room where the study occurred. The groups used these computers to search the internet for the correct scientific information they needed to build their food web poster. The preservice elementary teachers asked the facilitator of the activity questions if they were unsure how to make the food web poster correctly. If the facilitator was asked a question about constructing the food web poster they would ask leading questions to direct the preservice elementary teachers to the correct answer instead of directly answering the preservice elementary teachers' questions. Once all of the preservice elementary teachers built their posters, each group described their food web poster to the other groups by explaining the ecological role their specific arachnid played and how this indirectly or directly was beneficial to humans.

Randomization of Study

The sections of the university science education methods course were randomly assigned to either a control or treatment group. The university science education methods course sections, and therefore, the control and treatment groups were found to be homogenous with respect to the ethnicity, age and gender of the participants. Homogeneity tests that compared the age, gender and ethnicity of the treatment and control groups demonstrated that the demographic characteristics of the two groups were very similar ($p_{ethnicity}$=0.569, p_{age}=0.112, p_{gender}=0.554). Because of the random assignment of these sections and the homogeneity of the control and treatment groups, any differences in the disgust, perceived danger, fear or likelihood of incorporation between the control and treatment groups was caused by the arachnid workshop the treatment group participated in.

Living Arachnids Selected for the Study

The five living arachnids used in the study are presented in Table 1. These species represent five of the eleven extant orders of arachnids. The species used in the study were selected for multiple reasons. First, captive bred/captive born specimens of the five species can all be bought at reasonable prices in the US. It is essential to the ethics of the study to purchase captive bred/captive born arachnids versus purchasing specimens removed from their natural habitat. Purchasing wild caught arachnids can adversely impact the conservation status of the species and further decrease native arachnid population numbers. Second, because the five arachnid species reside in different orders their observable external morphology is dissimilar from species to species. Arachnids of this type are necessary for activity 1 which focuses on the functional characteristic of the arachnids' external morphology. Last, the arachnid species live in different global ecosystems. This further emphasizes the importance of arachnid biodiversity to different types of global ecosystems.

Two of the five living arachnids used in the study were venomous (i.e., *Brachypelma smithi* and *Pandinus imperator*) but these arachnids were not touched by humans during the study so no chance of envenomation existed at any point in the study. Neither of these two venomous arachnids is medically significant to humans. When venomous arthropods are used in educational settings they should never be touched by humans and all safety protocols should be followed. See Wagler (2015) and Wagler (2015a) for the proper safety protocols to follow when using living tarantulas in educational settings. The safety protocols outlined in Wagler (2015) and Wagler (2015a) can also be used when interacting with other venomous arachnids in educational settings.

Statistical Analysis

Analysis of fear, disgust, perceived danger and incorporation ratings over time.

Cumulative logit mixed models were utilized to analyze the Likert ratings of human fear, disgust, perceived danger and likelihood of incorporation associated with each of the five arachnids and for both the treatment and control groups across the three time points (i.e., pretest, posttest 1 and posttest 2). The cumulative logit mixed model (also referred to as a proportional odds model with a random effect) is an appropriate statistical model since the responses for fear, disgust, perceived danger and likelihood of incorporation are Likert scales (ranging from Not at all [1] to Extremely [5] and Extremely Unlikely [1] to Extremely Likely [4]) (Agresti, 2002). In particular, cumulative logit mixed models allow for the statistical modeling of ordinal responses while accounting for heterogeneity among subjects and accounting for dependencies among time points within subjects. This type of model is appropriate when modeling the probability of a response at a particular level from ordinal (i.e., Likert) scales. In the models, group (i.e., treatment or control), arachnid (See Table 1) and time (i.e., pretest, posttest 1 and posttest 2) are treated as fixed effects. A random effect for each time point within subject and course section was included in each model thus accounting for subject-to-subject and course-to-course variability. However, the course random effect variance was very near zero and subsequently dropped from the model. These three models will allow comparison of the treatment and control group subjects so as to examine any differences in these concepts across time. All modeling was performed in *R* using the ordinal package (Christensen, 2015; *R* Core Team, 2015).

Results

Figures 3-6 display boxplots of human fear, perceived danger, disgust and likelihood of incorporation scores for the five arachnids included in the study, the three survey points and research groups. The time points, labeled 1, 2, and 3, indicate the pretest, posttest 1 and posttest 2 time points, respectively. Each individual boxplot shows the distribution of the Likert responses for fear, perceived danger, disgust and likelihood of incorporation at each of these time points. The top row of the plots corresponds to the treatment group and the bottom row of the plots corresponds to the control group. Each animal of interest is also labeled below the group label for each individual plot. In Figures 3, 4 and 5, it is clear that the treatment group exhibit a steady and maintained decrease in the levels of fear, perceived danger and disgust across the time points, while the control group exhibits little change in these responses. Figure 5 exhibits a positive change in the likelihood of incorporation for each of the animals across time for the treatment group, while the control group shows little or no change in these responses across time. The statistical and practical significance of these anticipated relationships are evaluated in the following section.

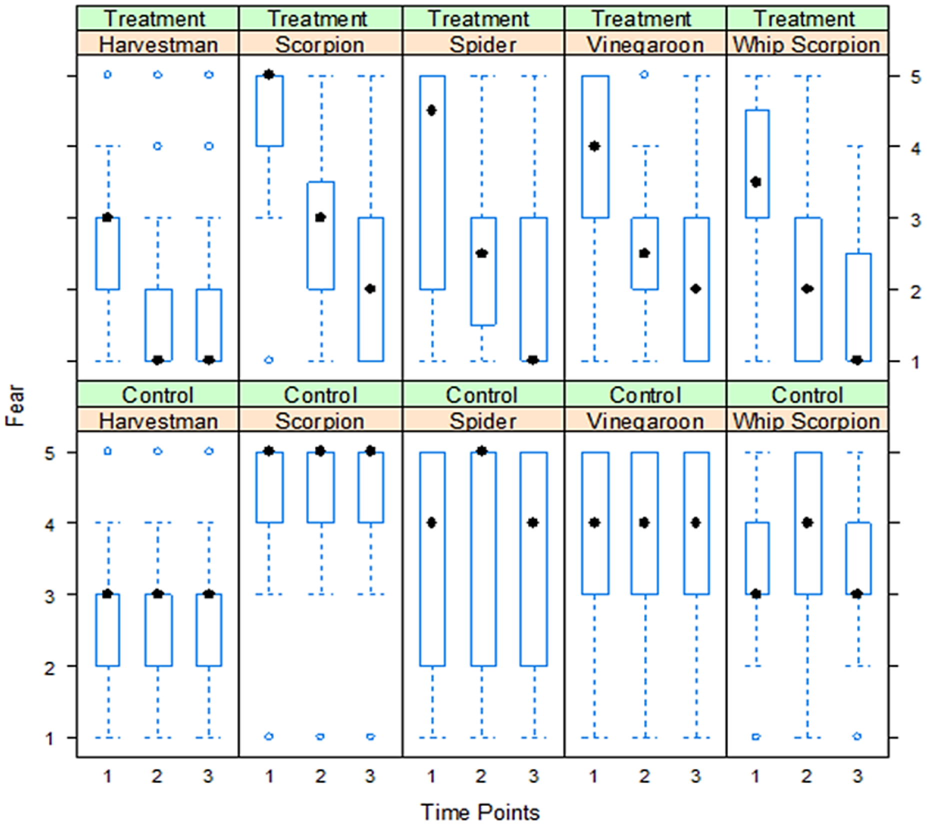


Figure 3. Boxplots Trellised by Group and Animal of self-reported Fear for Treatment and Control Groups (Time Points 1=Pretest, 2=Posttest 1, 3=Posttest 2, n=128 for treatment and control groups)

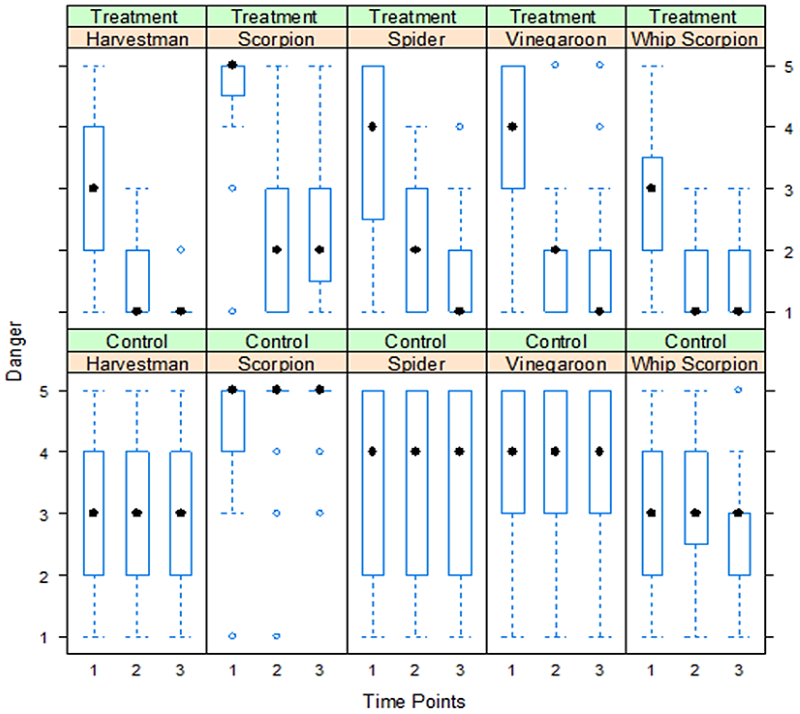


Figure 4. Boxplots Trellised by Group and Animal of self-reported Danger for Treatment and Control Groups (Time Points 1=Pretest, 2=Posttest 1, 3=Posttest 2, n=128 for treatment and control groups)

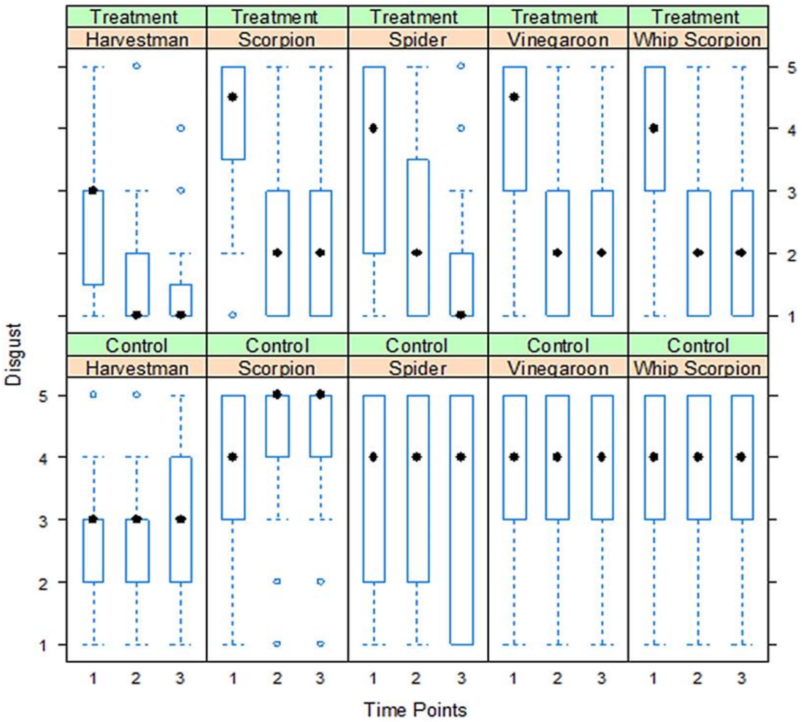


Figure 5. Boxplots Trellised by Group and Animal of self-reported Disgust for Treatment and Control Groups (Time Points 1=Pretest, 2=Posttest 1, 3=Posttest 2, n=128 for treatment and control groups)

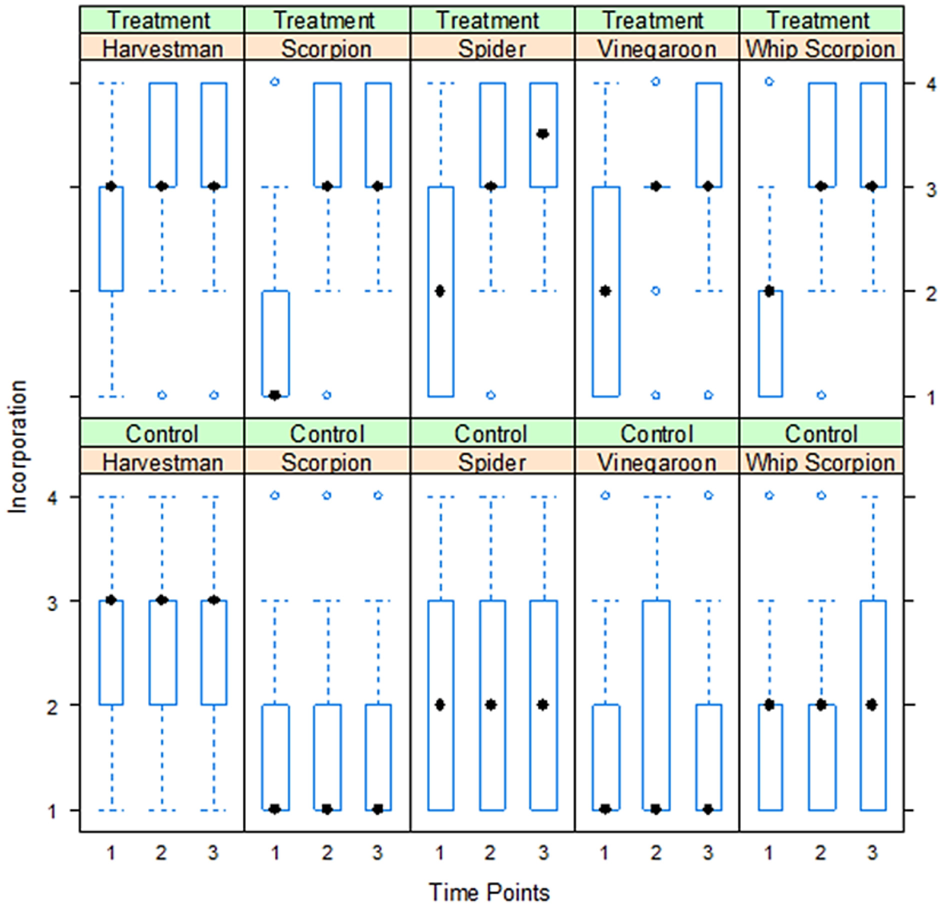


Figure 6. Boxplots Trellised by Group and Animal of self-reported Likelihood of Incorporation for Treatment and Control Groups (Time Points 1=Pretest, 2=Posttest 1, 3=Posttest 2, n=128 for treatment and control groups)

Analysis

The least squares means resulting from the cumulative logit mixed models employed for examining how human fear, danger, disgust and likelihood of incorporation change across time are described in Table 3. In particular, the least square means for the differences between the treatment and control groups are presented along with the associated standard errors and a multiplicity corrected *p*-value (Šidák, 1967). The family for the multiplicity correction is each emotion and belief being examined (i.e., fear, perceived danger, disgust and likelihood of incorporation) since these are evaluated independently. For the mean differences that are statistically significant, the effect size (Cohen, 1988) is also provided. The least squares mean estimate will be negative anytime the treatment mean is significantly lower than the control mean and positive when the treatment mean is significantly greater than the control mean for the fear, perceived danger and disgust ratings.

For the ratings of human fear, perceived danger, disgust and incorporation, the cumulative logit models support estimating a model with flexible thresholds and allowing for interactions between test time, animal and treatment group. This modeling results in lower ratings of human fear, perceived danger and disgust toward the arachnids for participants in the treatment group for both time points 2 and 3 (i.e., posttest 1 and 2), thus showing a sustained decrease in human fear, perceived danger and disgust and increase in likelihood for those exposed to the arachnid workshop that is both statistically significant and practically significant. In contrast, the treatment and control group differences are neither statistically or practically significant at time point 1 (i.e., pretest). These results demonstrate that there was no observable difference in the human fear, perceived danger, disgust, or likelihood ratings for the treatment and control groups at the outset and that the changes, when effected after the intervention, are significant and sustained. All effect size estimates are large when comparing the treatment vs. control at time points two or three. This exhibits the change in fear, perceived danger, disgust and incorporation for the treatment and control groups directly after and for a sustained period after the intervention. This consistent pattern is sustained not only across time, but also with regard to arachnid.

Table 3. Treatment - Control Least Squares Differences for Human Fear, Danger, Disgust, and Likelihood of Incorporation Ratings (multiplicity adjusted Šidák p-values reported)

	Animal	**Fear (SE)** ***d* (*p*-value)**	**Danger (SE)** ***d* (*p*-value)**	**Disgust (SE)** ***d* (*p*-value)**	**LOK (SE)** ***d* (*p*-value)**
Test Time Three	Harvestman	-3.20 (0.329) 1.31 (<0.001)	-4.79 (0.354) 2.11 (<0.001)	-3.07 (0.358) 1.42 (<0.001)	1.40 (0.311) -0.70 (<0.001)
	Scorpion	-3.94 (0.319) 1.83 (<0.001)	-5.55 (0.349) 3.09 (<0.001)	-3.56 (0.331) 1.50 (<0.001)	3.93 (0.326) -1.88 (<0.001)
	Spider	-3.48 (0.327) 1.15 (<0.001)	-4.42 (0.324) 1.76 (<0.001)	-3.17 (0.345) 0.72 (<0.001)	2.75 (0.315) -1.19 (<0.001)
	Vinegaroon	-3.96 (0.318) 1.83 (<0.001)	-4.47 (0.324) 1.88 (<0.001)	-2.95 (0.335) 1.05 (<0.001)	3.45 (0.319) -1.61 (<0.001)
	Whip Scorp	-3.42 (0.310) 1.48 (<0.001)	-3.37 (0.314) 1.67 (<0.001)	-2.76 (0.326) 1.50 (<0.001)	2.93 (0.309) -1.46 (<0.001)
Test Time Two	Harvestman	-2.61 (0.313) 1.10 (<0.001)	-3.60 (0.316) 1.70 (<0.001)	-2.36 (0.339) 1.03 (<0.001)	1.57 (0.311) -0.73 (<0.001)
	Scorpion	-3.11 (0.315) 1.27 (<0.001)	-5.43 (0.346) 2.62 (<0.001)	-3.35 (0.326) 1.50 (<0.001)	3.55 (0.321) -1.60 (<0.001)
	Spider	-2.27 (0.312) 0.77 (<0.001)	-2.85 (0.299) 1.22 (<0.001)	-1.97 (0.334) 0.72 (<0.001)	2.48 (0.313) -1.06 (<0.001)
	Vinegaroon	-2.51 (0.306) 1.11 (<0.001)	-3.17 (0.312) 1.34 (<0.001)	-2.68 (0.334) 1.05 (<0.001)	2.91 (0.314) -1.41 (<0.001)
	Whip Scorp	-2.87 (0.297) 1.52 (<0.001)	-3.42 (0.310) 1.77 (<0.001)	-3.24 (0.325) 1.50 (<0.001)	2.82 (0.308) -1.47 (<0.001)
Test Time One	Harvestman	-0.15 (0.295) * (0.612)	-0.29 (0.301) * (0.330)	0.17 (0.322) * (0.583)	-0.32 (0.306) * (0.303)
	Scorpion	-0.45 (0.326) * (0.170)	-0.26 (0.355) * (0.472)	-0.08 (0.338) * (0.808)	0.18 (0.326) * (0.587)
	Spider	0.19 (0.326) * (0.566)	0.19 (0.303) * (0.534)	-0.20 (0.335) * (0.559)	-0.25 (0.318) * (0.426)
	Vinegaroon	-0.07 (0.314) * (0.831)	0.12 (0.308) * (0.703)	0.01 (0.343) * (0.987)	0.13 (0.323) * (0.681)
	Whip Scorp	0.01 (0.294) * (0.979)	-0.11(0.288) * (0.714)	0.22 (0.328) * (0.510)	-0.15 (0.309) * (0.629)

*Indicates d (Cohen's d) is negligible (very near 0)

Discussion

Research Findings

The research question for this study assessed if the arachnid workshop changed the participants' levels of fear, disgust and perceived danger toward the five living arachnids used in the study. The research question also assessed if the arachnid workshop changed the participants' beliefs concerning the likelihood of incorporating information about arachnids into their elementary science classroom. This study has found that before the arachnid workshop (i.e., pretest) both groups (i.e., treatment and control) had elevated levels of human fear, disgust and perceived danger toward all five of the living arachnids and neither group planned to incorporate information about arachnids into their elementary science classroom (See Figures 3-6 and Table 3). After the workshop (i.e., posttest 1) and fifteen weeks later (i.e., posttest 2) the control group still had elevated levels of human fear, disgust and perceived danger toward all five of the living arachnids and very few had plans to incorporate information about arachnids into their elementary science classroom (See Figures 3-6 and Table 3). After the treatment group participated in the living arachnid workshop (i.e., posttest 1) the preservice elementary teachers had reduced levels of human fear, disgust and perceived danger toward all five of the living arachnids and had definitive plans to teach their elementary students about arachnids (See Figures 3-6 and Table 3). Fifteen weeks after the workshop these reduced levels of human fear, disgust and perceived danger continued to remain low (i.e., posttest 2) and the preservice elementary teachers still planned to incorporate information about arachnids into their science classroom.

The findings of this study add to a small but growing body of research exploring how the attitudes, emotions and beliefs of preservice elementary teachers toward arthropods affect their role as teachers (Wagler, 2010; Wagler & Wagler, 2011; Wagler & Wagler, 2012; Wagler & Wagler, 2013). This is the first research study, with any teacher population whether it be preservice or inservice, to quantify the impact human fear, disgust and perceived danger have on teacher beliefs about curriculum choice. Furthermore, this study presents the most biodiverse group of arachnids used to assess the emotions and beliefs humans have toward arachnids. Prior research has shown that preservice elementary teachers' beliefs (King & Wiseman, 2001; Moseley & Utley, 2006; Palmer, 2006; Utley, Moseley & Bryant, 2005; Wagler & Wagler, 2011) and attitudes (Pedersen & McCurdy, 1992; Syh-Jong, 2007; Weinburgh, 2007; Westerback, 1982) are malleable during their preservice training program. This study provides new evidence of the malleability of an extended list of preservice elementary teacher characteristics during their preservice training program. New to this study is the finding that preservice elementary teachers' levels of fear, disgust and perceived danger towards a wide diversity of arachnids are also malleable and can be reduced through effective arthropod education interventions in a positive educational environment.

It is known that certain groups of humans fear spiders, find them disgusting, perceive them as dangerous, have negative attitudes toward them and rank them as one of their least favorite animals (Bjerke, Odegardstuen & Kaltenborn, 1998; Davey, 1994; Gerdes, Uhl & Alpers, 2009; Prokop & Tunnicliffe, 2008; Prokop, Tolarovičová, Camerik & Peterková, 2010). Even though his is the case, little is known about other emotions and beliefs humans have towards other arachnids.

In this study we have found that humans find many different types of arachnids fearful, disgusting and perceive them as dangerous though the vast majority of arachnid species are harmless to humans.

Implications of the Study

Arachnids are essential to the health of Earth's ecosystems. Arachnids are involved in a myriad of fascinating and essential ecological processes that can greatly enhance the elementary science curriculum but sadly this study shows fear, disgust and perceived danger are barriers that are keeping preservice elementary teachers from educating their students about these amazing and essential animals. Just as arachnids are essential to the health of our planet they should be an essential part of the elementary school science curriculum. When elementary teachers fail to teach about arachnids their students do not learn at an early age about the large number of biological and ecological processes that arachnids are a necessary part of. This foundational knowledge is essential to mastering broader biological and ecological concepts students encounter in their later grades (Wagler, 2010; Wagler & Wagler, 2013). Students are placed at an educational disadvantage when they are not exposed to this foundational knowledge.

This randomized and controlled study provides the first glimpse into the emotions preservice elementary teachers have toward arachnids and how these emotions and beliefs impact their curriculum choices. This study demonstrates that preservice elementary teachers have no plans to teach their students about arachnids but when university instructors introduce simple enjoyable arachnid activities that are focused on how arachnids benefit humans these emotions can be changed and greatly increase the probability that the preservice elementary teachers in these courses will teach this essential information to their elementary students. Furthermore, the study demonstrates that, without educational intervention during the preservice teachers' university teacher preparation program, curriculum about arachnids and their essential importance to global ecosystems is not something teachers will welcome into their classrooms or feel comfortable teaching to their students. Based on the findings of this study it is recommended that instructors of elementary science education methods courses begin to implement these simple and enjoyable arachnid activities in their courses.

Limitations of the Study

The current study used five species of living arachnids (See Table 1) and the participants were overwhelmingly adult female Hispanic/Latino preservice elementary teachers. Sample sizes of males and other ethnic people groups that participated in the study were too small to make any statistical conclusions. Because of this, the results, findings and implications of this study can only be generalized to the five living arachnids used in this study and to adult female Hispanic/Latino preservice elementary teachers.

Future Research

This study had a longitudinal design where a pretest and posttest were given during the first week and then a second posttest was given during the sixteenth week. The data shows that even after fifteen weeks those that participated in the arachnid workshop still had reduced levels of fear, disgust and perceived danger toward all five of the living arachnids and had definitive plans to teach their elementary students about arachnids (though the levels vary slightly by arachnid type). What is not known is how long will the preservice elementary teachers emotions and beliefs toward this group of arachnids remain at these healthy levels. Future research is needed to answer this question.

After the preservice elementary teachers complete their elementary science education methods course they enter into their student teaching internship at a local elementary school. This semester long internship provides an excellent time to continue to track these preservice elementary teachers and monitor their levels of fear, disgust, perceived danger and likelihood of incorporation using both quantitative and qualitative research methodologies. It also provided a "real world" teaching experience in which the researcher can assess what barriers limit the student teacher's ability to incorporate information about arachnids (and other arthropods) into their student teaching classroom.

Conclusion

This study provides simple but effective arachnid activities that are focused on how arachnids benefit humans. These activities have been experimentally shown to decrease fear, disgust, and perceived danger and increase the likelihood of incorporation in preservice elementary teachers. Furthermore, this study shows preservice elementary teachers are open to participating in activities of this nature and after these educational interventions they our willing to teach their students about the positive ecological benefits arachnids provide both ecosystems and humans alike. Those that train future teachers in pedagogical strategies and scientific content related to the elementary science classroom should begin to implement these simple and enjoyable arachnid activities into their courses and continuing education activities. Considering how important arachnids are to the health of our planet and that their numbers are globally declining (IUCN, 2015), raising up a new generation of children that do not fear arachnids and find value in them could potentially be the impetuous for the preservation of the remaining fragmented and degraded habitats that many arachnid species currently live in.

Disclosure statement

No potential conflict of interest was reported by the authors.

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