Eastern gray squirrel (*Sciurus carolinensis*) foraging patterns in the presence of aerial predators

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The Eastern gray squirrel (*Sciurus carolinensis*) is a mammalian prey species, as well as one of the most common mammals found in the eastern United States. Studies indicate that the close proximity in which gray squirrels live to humans may potentially have a detrimental effect on their ability to perceive threats. The basis by which these studies operate is as follows: through cohabitation with non-threatening species (i.e. humans), and a lack of pressure from natural predators; urban gray squirrels could potentially display diminished reactivity in the presence of a predator. Trials observing squirrels in an urban area were carried out, wherein baited squirrels were exposed to a false predator, and their reactions recorded. Trials were conducted over a period of four days, alternating between experimental and control conditions. On experimental days, a false predator manufactured from household items and made to look like a large bird was hung from a line over the test area, and its movement controlled via fishing line. Control days were identical to experimental days, with the exception being the predator was replaced with a normal tree branch. A Chi Square test of Homogeneity was used to analyze the two treatment types and their outcomes (p=0). Results from the trials overwhelmingly showed that squirrels display an innate ability to differentiate foreign and potentially threatening objects from non-threatening objects, as well as the ability to escape from perceived danger.

Keywords: eastern gray squirrel, sciurus carolinensis, foraging, behavior, predation, aerial predator, mock predator
The specifics of mammalian foraging behavior differs between species, but as a whole, mammals will attempt to operate under the least treacherous of conditions (Lima et al. 1985). For animals that live under the threat of predation from another species, the challenge of obtaining food is made more perilous by the potential intervention of a predator. Thus, when searching for food; animals, especially small animals, must remain vigilant, and react appropriately to any apparent threats that they encounter.

The eastern gray squirrel (Sciurus carolinensis) is one of the most common and abundant mammals within North America, and is found in high numbers in both wooded and urban areas. Their diet includes many tree nuts, using peanut butter on saltine crackers has been a common practice in squirrel field observation studies (Makowska et al. 2007). As a result of their generalized diet they inhabit a variety of habitats. The behaviors of squirrels in urban environments are likely to vastly differ from those in wooded areas, and thus their behavior as species is difficult to standardize (Baker et al. 2015). In non-urbanized habitats eastern gray squirrels will exhibit a variety of behaviors in the presence of danger. Eastern gray squirrel will make a variety of specific warning calls, for aerial and terrestrial predators (McRae at. el 2015). Conversely, these behaviors are less often observed in urban squirrels. Wherein squirrels in rural areas are less accustomed to the movements of large animals, urban squirrels are constantly subjected to the movements of humans. Additionally, humans lack the tendency to attack eastern gray squirrels, and as a result both species have largely learned to ignore one another (Cooper et al. 2008).

In an attempt to understand the effect that human urbanization has on indigenous animal populations (i.e. eastern gray squirrels), an experiment was carried out in order to better
understand how, if at all, living in an urban environment causes a squirrel’s behavior in the presence of a supposed predator to change.

This study aims to evaluate the reaction of the UMD gray squirrel population to the presence of a mock aerial predator in a test area with peanut butter saltine crackers. The object of the study is to determine if the urban location of these squirrels has affected their natural response to flee from natural predators. It was hypothesized that the presence of an aerial predator will result in a fleeing or spooked outcome in the squirrels observed. This hypothesis was tested by setting up a test area with a moving mock predator and a moving stick as a control.

MATERIALS AND METHODS

Study location— This study was performed on the University of Maryland College Park Campus. The test site was constructed in front of the Lee Building near the Chapel. A 12x12 area was established between two large trees.

Study subjects— Data was collected from 39 Eastern gray squirrels over the course of four days. The subjects were specifically those squirrels that inhabit the University of Maryland Campus.

Experimental design— Gray squirrels on the University of Maryland campus are known to participate in more active foraging at dawn, or very early morning. The squirrels were observed for approximately two hours each day, between 6:30 AM and 8:30 AM.

The materials necessary for the experiment included a fishing pole, fishing line, string, tape, a water bottle, a makeshift predator, a stick, saltine crackers and peanut butter. The “predator” was constructed using an empty 2 liter soda bottle, cardboard, wooden paint stirrers, metal eye hooks and black spray paint. The pieces were put together using hot glue (Figure 1). The predator was hung between two trees using string. A fishing line was also attached to the
predator, and the fishing pole was used to move the apparatus when the squirrels approached the study area.

For the control, a large stick replaced the predator. The setup was the same and the fishing pole was used to move the stick when the squirrels were within the 12x12 area. Within the study area, 17 saltine crackers with creamy peanut butter were randomly arranged. The study was carried out over four days, including two experimental days and two control days. The study location and the number of crackers was consistent for all four days.

**Data collection**— During each day, every squirrel that entered the area was recorded. Once the squirrel was in the area, the predator or the stick was moved using the fishing pole to simulate a threat from above. Observers sat 100 feet downwind, to reduce the influence of human presence, smell and noise. Then, the behavior of each squirrel was classified as spooked or un-spooked. Running away and running up a tree, with or without the food, were classified as spooked behaviors. Un-spooked behaviors included remaining in the study area, eating the food within the study area, and “playing” in the study area.

**Data analysis**— The experiment was conducted using two treatment types, presence and absence of an aerial predator, and two possible outcomes, spooked and un-spooked. Because of the qualitative nature of the data and small sample size of 39 trials, a Chi Square test of homogeneity with a p-value of 0 was used to assess the pattern of the two treatments.

**RESULTS**

A total of 39 trials were conducted over a 4 consecutive day period. A total of 19 trials were conducted with the presence of a mock aerial predator over a two day period and a total of 20 trials were conducted in the absence of an aerial predator. In the presence of the predator a
total of 17 series were classified as spooked and 2 were classified as un-spooked. In the control treatment of no predator there were no squirrels classified as spooked and a total of 20 squirrels were classified as un-spooked (Figure 2). The data collected is qualitative, and the sample size is not large enough to run a parametric test. A nonparametric, two variable Chi Squared test was used to analyze the data.

This data was used to make a contingency table (Table 1) for a Chi Squared Test for Homogeneity, that tests the null hypothesis with the assumption that the two outcomes are equal given the same treatment. Our data proves our results to be statistically significant \( (x^2=31.7, \text{df}=1, p<0.05) \). Since the p-value is less than 0.05, we reject the null hypothesis. From this analysis we can conclude that there was a significant difference in behavior among the two treatment types and the presence of an aerial predator.

A link serves as an appendix for results, which includes video footage for trial outcomes in the presence of an aerial predator.

DISCUSSION

Our data supports our alternative hypothesis. The eastern gray squirrels were significantly more spooked in the presence of an aerial predator than in the absence of the predator (Table 1). When the predator appeared to be moving, the majority of the squirrels quickly fled the area to hide (see appendix videos). This suggests that even though these squirrels are considered to be urban and under different environmental pressure the response to danger is innate, and is not affected by urbanization of squirrels. Two squirrels did not flee, but instead took the crackers and appeared to be watching the model as it moved. These squirrels could have noticed over the course of our experiment that the aerial predator did not pose a threat to them, allowing them to be unaffected by its presence. When the predator was absent, the squirrels spent more time
foraging (eating the saltine crackers). During our control trials, we found that there were 0 non-spoaked squirrels (Table 2). To prevent having 0 un-spooked squirrels in our control data set and to gather more accurate data over all, we would have to increase the number of trials performed. We did not test for other confounding factors besides aerial predators.

Increasing the number of trials would have greatly improved our data. We could have spent a longer time observing the squirrels and increased the number of days we conducted our experiment. This would have increased our sample size, subsequently strengthening our conclusion, and proving the effects of confounding factors to be null. By conducting more trials, we could have seen how squirrel behavior is affected by the surrounding environment. Although we tried to simulate the movement of the hawk, it was somewhat unrealistic. Designing a way to more accurately depict this movement could have improved our experiment. For example, moving the hawk along the line between the two trees could have been more representative of a threatening predator.

Our results expand on the findings of other researchers. We noticed that the urban squirrels did not exhibit alarm calls in the presence of the aerial predator, although they thought the predator posed a threat to them (McRae et al. 2015). Urban squirrels come in contact with humans so frequently on this campus. While we set up and took down our experiment, the surrounding squirrels did not flee the area. While this doesn’t provide substantial proof, we found this to support the theory that they don’t view humans as a threat (Cooper et al. 2008).

Further research could be conducted to understand the reactions of the Eastern gray squirrel in the presence of predators. Homeowners may be able to use models to scare off squirrels that inhabit their garage or porch. This theory could also be tested in different areas within the University of Maryland campus to see if the relationship between the location and the
predator has any effect on the squirrels’ behavior. A possible question to explore is whether squirrels that frequent parking lots, as opposed to grassy areas, would be more or less spooked by a predator. Location in an urban habitat could play a role in the desensitization of squirrels, so that they are less reactive to potential predators. We could also study how weather patterns affect the reaction of the squirrels to a predator. It would be interesting to see if, in the winter when food is scarce, the squirrels would take the crackers despite predator threats.

LITERATURE CITED


Table 1: Contingency table used in the Chi Squared Test for Homogeneity: sorted as treatments (the presence or absence of the predators) and the outcomes (spooked or un-spooked) ($x^2$, df=1, p<0.05).
**Figure 1**: Mock predator made from a soda bottle, cardboard, wooden paint sticks, hot glue and metal eye hooks.
Figure 2: The reaction of the presence or absence of an mock aerial predator in the 39 trials.

Error bars are absent because this is a graphical representation of the quantitative data, error was not qualitatively analyzed.
APPENDIX

Appendix:

Joe’s Flickr: https://www.flickr.com/photos/126221952@N03/albums/72157667079460340