

## Effects of Interspecific Competition on the Foraging Habits of Eastern Grey Squirrels

Jared Swensen, Michael Villagomez, and Cecil Vojnikovic  
Department of Biology  
Lake Forest College  
Lake Forest, Illinois 60045

### Introduction

Optimal foraging theory states that organisms will want to maximize their energy gain relative to energy expenditure when foraging. This process can result in a variety of different strategies undergoing adaptation for foraging. These often involve trade-offs, such as having to forage for a longer amount of time if the journey took longer.

Competition would theoretically affect on foraging behavior. Since competition affects resource availability, it alters the amount of energy that organisms can obtain when foraging in an areas with high competition. Previous studies have found that *Sciurus carolinensis* (eastern gray squirrels) will interrupt foraging and exhibit alert behaviors when competitors are heard nearby (Jayne et al., 2015). They will also return to low-density food patches more rapidly in the presence of intraspecific competitors (Hopewell et al., 2008). Intraspecific competition between squirrels has also been shown to reduce foraging efficiency and speed (Teichroeb et al., 2024). However, competition can also have a positive effect, such as reducing predation risk and making it easier to find food (Jayne et al., 2015). These trade-offs may lead to competition either increasing or decreasing net energy and risk, depending on the situation.

Our experiments examine the effects of competition on *Sciurus carolinensis* (eastern gray squirrel) foraging, measured by the giving-up density (GUD) of feeding trays. The first experiment tested whether or not intraspecific competition would affect the GUD. The null hypothesis was that there would be no difference in GUD between trays with no intraspecific competition and the trays with intraspecific competition (represented by a mirror). The alternative hypothesis is that there is a difference in GUD between the trays where there was no intraspecific competition and the trays where there was intraspecific competition. Our prediction was that the GUD would be higher in trays with a mirror, as the perceived intraspecific competition would lead to less optimal foraging, as another squirrel being there would lead to fewer peanuts in that tray. The second experiment tested whether or not interspecific competition (represented by a crow statue) or intraspecific competition (represented by a squirrel statue) would have a stronger effect on the squirrel's GUD. A crow was used to represent interspecific competition because it competes for similar resources (Jayne et al., 2015). The null hypothesis was that there would be no significant difference in GUD between the tray with intraspecific competition and the tray with interspecific competition. The alternative hypothesis was that there would be a significant difference in GUD between the tray with intraspecific competition and the tray with interspecific competition. Our prediction was that the GUD would be higher in the tray with intraspecific competition, as this typically has a stronger effect, leading the squirrels to avoid it more.

### Methods

Experiments were conducted behind Nollen Hall on the south campus of Lake Forest College, Illinois. The experiments began on April 3<sup>rd</sup> and the final trial was run on April 29<sup>th</sup>. Each trial consisted of two stations side by side, approximately 8 feet apart. Each station had a plastic tray filled to about 1/3 with sand. Approximately 60 grams of unshelled peanuts were mixed within. Stations were set out for 45 minutes to 2 hours. Afterwards, the remaining peanuts were collected and weighed to determine the GUD. The grams of peanuts lost per hour were then calculated for each trial by comparing the initial versus the final weight.

### Experiment 1:

For the first experiment, one tray was accompanied by a large mirror that leaned against the side of the tray. This mirror was used to

\*This author wrote this paper for Biology 220: Ecology and Evolution taught by Dr. Josh Hedge.

assess intraspecific competition, as the squirrel would see another squirrel when it looked at the mirror. The other tray had no modifications.

To analyze the data, a two-tailed unpaired t-test was performed. This was chosen as the alternative hypothesis was a significant difference in either direction, and the treatments were two unrelated trays.

### Experiment 2:

The second experiment had one tray with a life-size squirrel statue placed within (image 1). The second tray contained a model crow placed within (image 2). This modeled a choice between perceived intraspecific and interspecific competition. To analyze the data, a two-tailed unpaired t-test was performed. This was chosen because the alternative hypothesis would be a significant difference in either direction, and the treatments were two separate trays.



Image 1. Treatment 1 for the second experiment: a realistic squirrel statue.

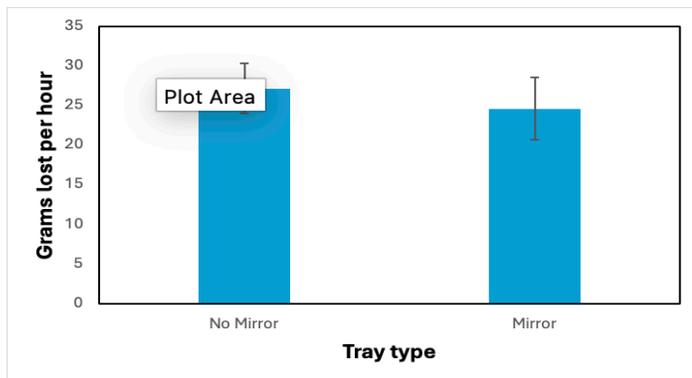


Image 2. Treatment 2 for the second experiment: a realistic crow statue.

### Results

#### Experiment 1

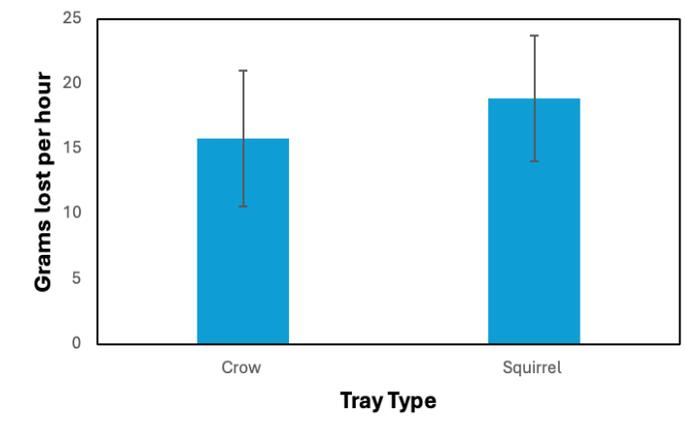
There was no significant difference in mean grams lost per hour between tray types for experiment 1 ( $t(18) = .5042, p = .6202$ ). The tray without a mirror had a mean loss of 27.19 grams per hour, while the tray with a mirror had a mean loss of 24.64 grams per hour (Figure 1). There were also no apparent behavior differences between the two trays.



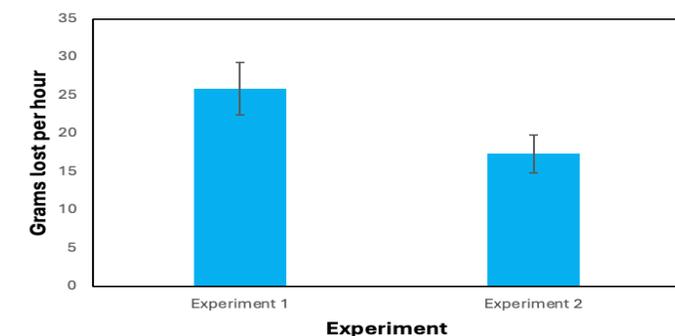
**Figure 1. Mean results for the first experiment.** Grams lost per hour in the tray with a mirror accompanying versus the tray without a mirror. The difference was found to be insignificant ( $t(18) = -.5042$ ,  $p = .6202$ )

### Experiment 2

The second experiment also yielded no significant difference in grams lost per hour between the tray with a crow statue and the tray with a squirrel statue ( $t(20) = -.4352$ ,  $p = .6681$ ). The tray with a crow statue had a mean loss of 15.85 grams per hour, while the tray with a squirrel statue had a mean loss of 18.92 grams per hour (Figure 2). When approaching the trays, squirrels seemed hesitant and curious. They mostly chose to eat on the side opposite the statues. The mean grams lost per hour was taken for both experiments 1 and 2 and compared (Figure 3). The results were nearly statistically significant, with the first experiment having a higher mean grams lost per hour (25.91) than the second experiment (17.39) ( $t(40) = -1.9666$ ,  $p = .05619$ ).



**Figure 2. The mean results for the second experiment.** Grams lost per hour in the tray with a squirrel replica versus tray with crow replica. Results were statistically insignificant ( $t(20) = -.4352$ ,  $p = .6681$ ).



**Figure 3. Mean results for both tray types in experiment 1 versus those in experiment 2.** Results were near significant, with more grams being lost per hour from the trays in experiment 1 ( $t(40) = -1.9666$ ,  $p = .05619$ ).

### Discussion

The data failed to reject either null hypothesis. In the first experiment, there was no significant difference between trays, indicating that the squirrels have no preference for the blank tray or the tray with intraspecific competition represented by a mirror ( $t(18) = .5042$ ,  $p = .6202$ ). The second experiment also had no significant difference between trays. This would indicate that the squirrels have no preference between the tray with a crow statue (interspecific competition) and the tray with a squirrel statue (intraspecific competition). The comparison between the two indicated a nearly significant difference in grams lost per hour in the first experiment compared to the second experiment ( $t(40) = -1.9666$ ,  $p = .05619$ ). This may indicate that the squirrels were possibly discouraged from foraging when they spotted the visual competitors (statues). However, given only a near-significant value, major conclusions should not be drawn.

If the statues were perceived as competitors, the results of the first experiment suggest that the positive benefits of other squirrels balance out the decreased foraging efficiency that competitors bring (Teichroeb et al., 2024). While it has been found that the sounds of competitors cause squirrels to pause and engage in alert behaviors, it is possible that this behavior does not necessarily mean that squirrels perceive competitors as an inherent negative (Jayne et al., 2015).

The data for the second experiment are consistent with the finding that there was no difference in squirrel foraging behavior when corvid sounds were compared with squirrel sounds (Jayne et al., 2015). While this may seem intuitive, as intraspecific competition is typically thought to be stronger than interspecific competition, there is evidence that organisms can gather important information about food sources from heterospecifics just as well as conspecifics (Avargues et al., 2013). If squirrels are utilizing either to gather information about the food source, it may not matter which species is present.

Some of the significant issues that this study faces arise from the fact that the representations of competition were possibly not very convincing. Since they were simply realistic statues, they did not move, smell, or sound like typical competitors. Additionally, in the first experiment, some squirrels did not even pause to look into the mirror, so they were unaware of the potential intraspecific competition. If the squirrels did not view these representations as competitors, the results would be an inaccurate measure of how competition affects foraging behavior. Another issue was that the representation of intraspecific competition was changed from the first to second experiment. After seeing that many squirrels were not even looking into the mirror during the first experiment, the intraspecific indicator was switched to the squirrel statue.

For future studies, it would be helpful to look more into the effect of competition with more convincing stand-ins. Due to the near-significant difference between the first and second experiments, it is possible that the statues discouraged the squirrels' visits because they looked more like realistic competitors. With this in mind, studies in which one tray has no statue and the other tray has a squirrel statue would help clarify this result. Adding certain things to the statues to make them more realistic, such as the smell of a typical squirrel, or some type of sound production.

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