

The Effect of a Water Barrier on Small Mammals

Peromyscus maniculatus and Myodes gapperi

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Abstract

Small mammals are some of the key organisms that play an important role in the ecosystem by dispersal of seeds and spores as well as key species in the food web. Swimming for small mammals can be important because they can use the water barrier to return to their home range, search for food, and escape from predators. I hypothesize that owl calls will have an effect on *Peromyscus maniculatus* and *Myodes gapperi* and cause their movements across a water barrier to decrease. Results found no significant measures for time to swim one meter, time to enter water, time exploring or standing still time. This study needs a larger sample size as well as a look into the species reactions being the same.

Introduction

Mice are organisms that play an essential role in forested ecosystems. They are primarily useful because they help to disperse seeds and spores, and serve as seed predators (Bakker, 1996). This is a major contribution in plant diversity within a community. They circulate energy and nutrients through the food web by being primary consumers as well as secondary consumers. Mice are omnivores and eat primarily insects, fruits, fungi and seeds that they find mainly through olfaction (Kurta, 1995). Moreover, they are preyed upon by many predators as well, including hawks, owls, snakes, short-tailed shrews, foxes, minks, weasels, bobcats and coyotes (Kurta, 1995). Two common small mammal species in deciduous woodlands of the Great Lakes region are the forest deer mouse (*Peromyscus*

maniculatus) and the red-backed vole (*Myodes gapperi*). These species have shown an ability to swim in past experiments for two different reasons: to return back to their home habitat, and as a defense mechanism against predators (personal observation).

Movement studies have been studied intensely for small mammals (Liro, 1987). A part to this study that has not fully been studied is the effect of water barriers. Previously reported, mice have used small stream barriers to find new home ranges (Sheppe, 1965). Past experiments have done comparison experiments on mice use of water. The results showed a large difference in the number of individuals that used the water. The data also showed a large difference in species swimming capabilities (Esher, 1978).

Previous experiments, testing for the effect of water barriers on the homing ability of *Peromyscus maniculatus*, determined that some displaced mice crossed a water barrier to return to their home ranges (Anwieler, unpublished manuscript). This supports the idea that mice have the ability to swim if they choose to return to their home ranges. Other past experiments support the idea of swimming capabilities by testing their strength in swimming. This was done by evaluating the time that they can keep their noses above water, which on average was 3.3 minutes for *P. maniculatus*, and 3.45 minutes for *Myodes (=Clethrionomys) gapperi* (Getz, 1967).

The question I will be addressing is how prone the forest deer mouse (*Peromyscus maniculatus*) is to swim in response to owl calls compared to the red-backed vole (*Myodes gapperi*). Given the reported swimming abilities both species I predict that *Myodes gapperi* will make it to the opposite platform at a faster rate because they are stronger swimmers. I hypothesize that when the species are exposed to owl calls, this will decrease the rate at which both species will explore the water. This can also be broken into two parts, grooming or standing time and exploratory time, which is classified as a measure of time a specific animal uses to investigate a specific area. Previous studies have shown that mice decrease their exploratory behavior when exposed to stress (Berridge and Dunn, 1989), such as the presence of a predator. I predict exploratory behavior will decrease due to the stress of predation. I hypothesize that grooming time will increase with owl calls given data from other experiments that address a decrease in movement with stress increase (Berridge and Dunn, 1989). The species exploratory behavior will be evaluated with and without owl calls. When the owl calls are present, I expect there to be less exploring time and more sitting time before they enter the water.

Methods

Traps were set at various locations on the University of Notre Dame Environmental Research Center property. Species were trapped with Sherman traps baited with a mixture of rolled oats, sunflower seeds and peanut butter. For a

sufficient sample number we used 10 individuals of each species for two types of trial in the lab experiment totaling to 40 mice and voles. All captures were individually marked, weighed, sexed, and if they were not *Peromyscus maniculatus* or *Myodes gapperi* then they were released. During this study, *Peromyscus maniculatus* and *Myodes gapperi* were housed individually in plastic cages sized 7.5 x 11.5 x 5 lined with pine bedding at the UNDERC Aquatic Lab. The species were provided with rat chow and water ad libitum.

There were four parts to this experiment: how owl calls affect the use of water barrier, the comparative time it takes forest deer mice and red-backed vole to enter the water, the rate it takes the two to swim the meter distance in the tank, the comparison of exploratory behavior of the two species, and the time spent grooming. Every trial was run with a food incentive on the opposing island. The forest deer mouse and the red-backed vole were selected because of their abundance in this area. Each mouse was randomly placed on a platform (15cm x 10cm) surrounded by twenty cm of 25° C water. The platform was just above the water level and large enough with a ramp so that the mouse did not fall in instantly. The experiment was conducted in the dark to mimic natural conditions. To observe small mammal behavior cameras and infrared light were used. From reported data on maximum amount of time these species can swim, trial time was limited to 30 minutes inside the aquarium to allow full exploring time and swimming time. Trials were stopped when the subject swam across the tank to the

opposing island. When each trial was completed the mice were released back to their site of capture and the cages were washed with 10% bleach.

Data was analyzed with an ANOVA and chi-squared test. Data collected were: number of animals that swam, the exploratory time, time before entering the water, time to swim one meter, and time spent grooming. These data were taken with and without owl calls. This experiment has two time measures: latency to swim and the amount of time it took to swim, one meter, which were used as dependent variables. Latency to swim was broken into two parts: time exploring and time grooming or sitting still. Independent variables were species and the presence or absence of an owl call. This experiment will provide more information on how prone mice are to use a water barrier with the threat of predators by comparing the time it takes for the mice to swim with the owl calls and without. The experiment will also give a comparative relationship for the two species.

Results

There were 20 mice and 20 voles collected. Each species had 10 trials with owl calls and 10 without. Half of the ten *Peromyscus maniculatus* swam in response to owl calls. When owl calls were eliminated, there were seven mice that swam. With owl calls present three *Myodes gapperi* swam, and without owl calls five voles swam.

A chi-square test was conducted to test the proportion of successful swimming trials in the presence and absence of owl calls. This test presented no significant relationship between species swimming or not ($X^2=0.133$, $df=1$, $p=0.71$). An analysis of variance was then performed for time before entering water, time to swim a distance of one meter, exploratory time before entering the water, and grooming or sitting time before entering the water. Time before entering the water showed no significant difference when using species and owl call presence ($F_{1,36} = 1.111$, $p = 0.300$). The time each mouse or vole took to swim one meter was not statistically significant ($F_{1,16}=0.209$, $p =0.654$). Time before entering into the water was broken into two categories, exploratory behavior and grooming or sitting time. Exploratory time was transformed into a proportion of latency time. This then was transformed using arcsin transformation. The analysis of variance for exploratory behavior resulted in a non-significant value ($F_{1,36} =.064$, $p =0.801$). The final analysis was evaluating relative grooming time which was transformed using an arcsin transformation, which was also non-significant ($F_{1,36} =.4025$, $p=.876$).

Discussion

This experiment primarily addressed the effects of owl calls on how prone *Peromyscus maniculatus* and *Myodes gapperi* are to swim. According to our hypothesis owl calls should cause a decrease in movement, which was not supported by the data. The chi-squared test which analyzes how many mice or

voles swam was not-statistically significant which was unexpected due to past experiments that showed decrease in movement as a result of stress (Berridge and Dunn, 1989). This discrepancy could be caused by the sample size being too small.

Moreover, we analyzed the time each species took to enter the water and the effects of owl calls and found no significant difference. The effects of owl calls had little impact. When owl calls were present, *Peromyscus maniculatus* entered the water faster but this was not statistically significant (Figure 1). For *Myodes gapperi*, they entered the water more quickly when owl calls were absent, but this also was not statistically significant (Figure 1). The comparison of the species was very similar and not significant. There were four cases that were deleted from analysis because the subjects never entered the water. Small sample size is more than likely the reason for the results being non-significant. Although the values are not significant, the amount of variation should be noted. The variability was relatively the same, but was large, potentially masking the effects of owl calls on swimming behavior. This should be further studied to determine how much alike these species are in terms of their motivation to swim.

The part of the experiment that compared mice and voles time to swim one meter resulted in a non-significant relationship. We had hoped to see from our prediction that the voles would swim faster due to their strength in the forced swim trial (Getz, 1967). The data was calculated using an ANOVA and 20 cases

were deleted due to missing data, or the subjects that didn't swim, which severely reduced the sample sizes. The missing data could be the reason for this part of the study being non-significant by having a small sample size. Both species swam the meter faster when owl calls were tested but differences were not statistically significant (Figure 2). Although the results are not significant, similar issues about the amount of variation in behavior apply as well. This indicates that the two species react in a similar manner. Further studies would determine how much these species are alike in behavioral activities and strengths.

Time before entering the water was broken into two different parts, exploratory time and standing still or grooming time. Both parts to this experiment were non-significant and failed to reject the null hypothesis. Exploratory time was expected to decrease when owl calls were present which was demonstrated by *Peromyscus maniculatus* but was still not statistically significant. *Myodes gapperi* showed the opposite with an increase in exploratory time with owl calls present (Figure 3). The variance in the graphs could represent the species reacting to the trials in a similar way. Grooming time or standing still time increased for both species as owl calls were introduced. This is what we predicted but the results were not significant. Sample size could be the reason the statistics didn't show significance.

Getz's (1967) experiments was primarily forced swim tests, in which animals were not able to choose whether to swim. This experiment asked how prone small

mammals choose to swim. This added element caused increased variation in results from the previous experiments. The past experiment had a full sample size with all 10 of the subjects that swam and had a wide range of species types, which may explain why their results were not supported by mine. Further experiments could evaluate how effective owl calls disrupt other behavioral activities. Other ways to evaluate this experiment could have been to use scents or visual cues. This might have had a larger impact for predator presence. The sample size was not large enough to be conclusive and the results indicated that sound did not make a difference. There might possibly be outside factors that impacted the number of mice that swam. From the data, mice will not be more prone to swim if predators are present. There is not a large difference in *Peromyscus maniculatus* and *Myodes gapperi*, which represents a similar behavioral reaction to water as a barrier.

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Figures

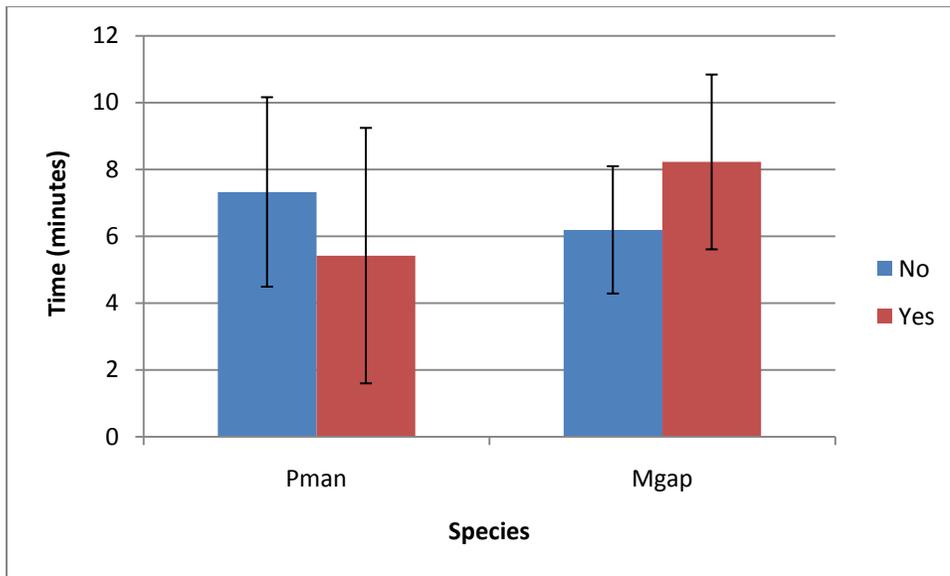


Figure 1. Mean time it took for each species with and without owl calls to enter the water. For *Peromyscus maniculatus*, owl calls had the fastest time. *Myodes gapperi* showed a faster rate without owl calls. This did not result in statistical significance ($F_{1,36} = 1.111, p = 0.300$).

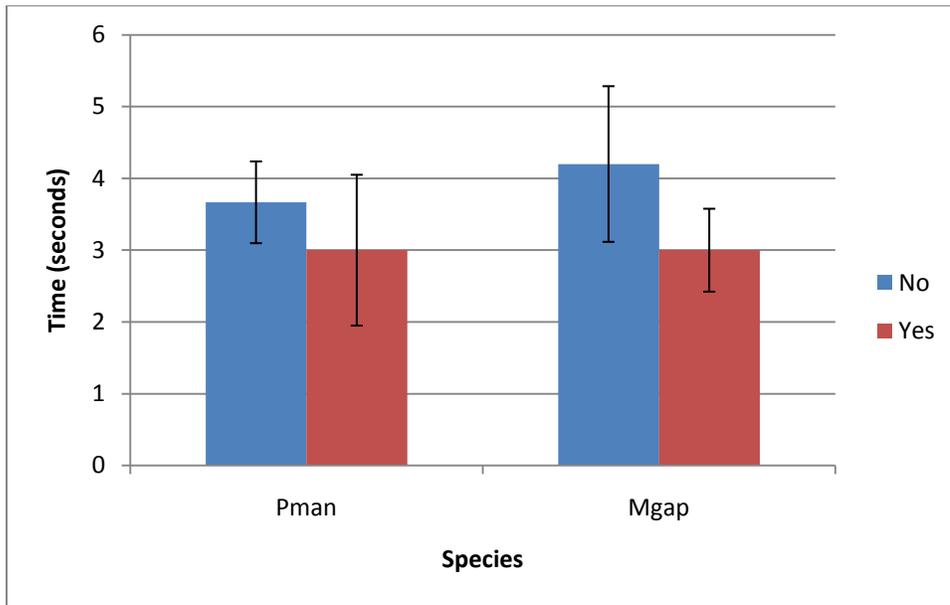


Figure 2. Mean time for each species with and without owl calls to swim one meter. *Peromyscus maniculatus* swam more quickly with owl calls than without. *Myodes gapperi* also had the same trend where they swam faster with owl calls. This did not result in statistical significance ($F_{1,16}=0.209$, $p=0.654$).

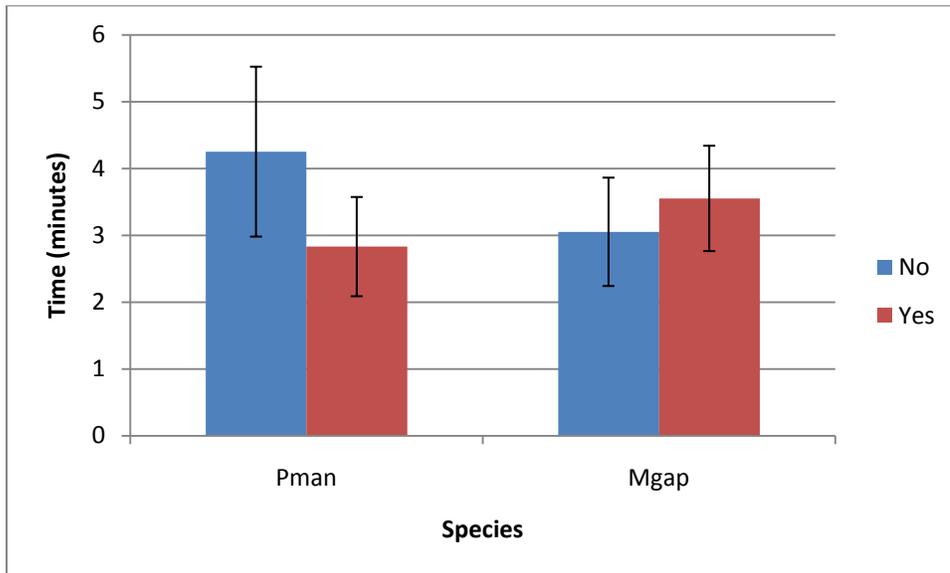


Figure 3. Mean time spent exploring before entering the water with and without owl calls for *Peromyscus maniculatus* and *Myodes gapperi*. *Peromyscus maniculatus* showed a shorter time exploring when owl calls were present. *Myodes gapperi* explored less when owl calls were not present. This did not result in statistical significance ($F_{1,36} = .064$, $p = 0.801$).

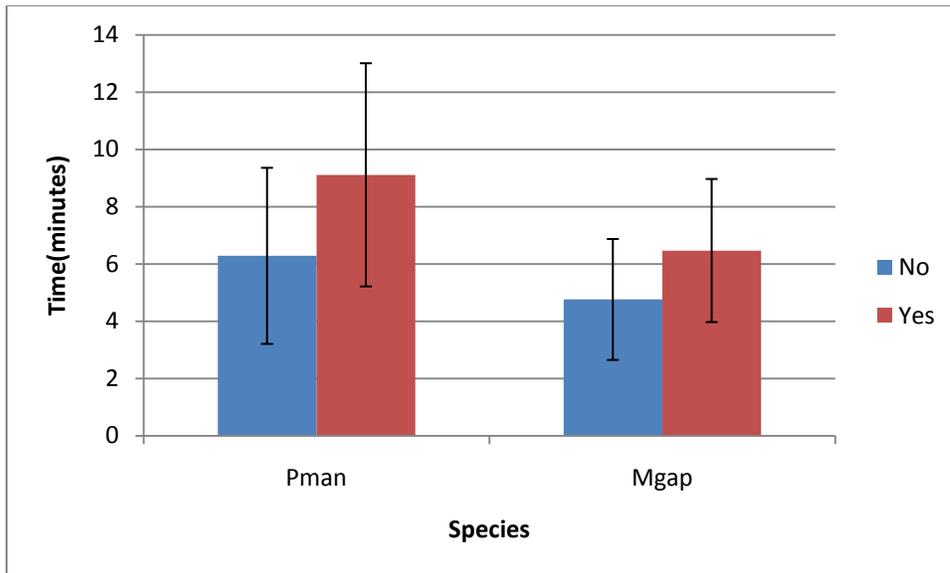


Figure 4. Grooming time or standing time for *Peromyscus maniculatus* and *Myodes gapperi* with owl calls present and absent. *Peromyscus maniculatus* showed an increase in time when owl calls were present. *Myodes gapperi* also showed an increase in time when owl calls were present. This did not result in significant statistical results ($F_{1,36}=.4025, p=.876$).