The Taming of the Shrew: A study looking at the behavioral response of Northern Short-Tailed Shrews (*Blarina brevicauda*) to the Scent of a Predator

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Abstract

Northern Short-tail shrews (*Blarina brevicauda*) are among the most common shrews found in the Northern Great Lakes region of the United States. However, their interactions with other animals, including predators, is poorly studied. In this study, *B. brevicauda* was placed in an aquarium separated into three zones with either the urine of mink or water placed randomly on the end zones and recorded for 30 minutes. The behavior was scored for exploring, motionless, and other behavior. The shrews spent a similar amount of time in the zone with the urine of mink and the zone with the control substance. This trend continued as the shrews also spent a similar amount of time exploring and remaining motionless. Though there were no significant results, further research can give more insight to shrew antipredator behavior and their relationship with predators.

When it is difficult to see in a complex habitat, many animals rely on odor cues to be able to gather information on surrounding organisms. Odor cues have a wide sensing range which is helpful for prey to sense surrounding predators in their environment that mark their territory using urine or feces (Arakawa *et. al.* 2010 and Downes 2002). Prey behavior is strongly influenced by scent of predators which can induce a change in prey behavior in order to increase their chances of survival (Downes 2002; Fanson 2010; Pillay *et al*, 2003). Responses to the predator cues can vary depending on the concentration of the scent which allows the prey to assess the immediate risk of predation and act accordingly (Weissman *et al*, 2014).

Many studies have assessed the response of prey items, particularly small mammals, to predator cues and have scored a variety of responses. For example, striped mice will decrease their level of activity, increasing their inactive behavior in response to exposure of the feces of a predatory snake (Pillay *et al*, 2003). Fanson, 2010 looked at the foraging habits of the white-footed mouse in response to the scent of a predator. The study found that the mice would change the time and microhabitat of their activity, however, they did not change the amount of food that they consumed. This suggests that there is possibly a tradeoff between antipredatory behavior and the need for to gain and conserve energy. Predator scents can even change results of sampling prey populations. One study found that the odor of traps previously occupied by the Northern short-tailed shrew, a predator to other small mammals, significantly decreased the trapping success of small rodents (Brittain *et al,* 2005).

Shrews are a unique model to study antipredator behavior as they are both predator and prey within the animal community. Though shrews are some of the smallest mammals in the world, they are described to be voracious foragers. Their small size and high metabolism makes it so that they must forage almost constantly (George *et al*. 1986). As generalist foragers they must eat everything that comes across their path, which sometimes includes each other. However, much is left to the imagination as shrew behavior and their relationships to other animals is poorly studied.

Among the small mammals is the most fearsome shrew of all, the Northern short-tailed shrew (*Blarina brevicauda*). Smaller than most mice in their range, *B. brevicauda* is one of the largest shrew species in the Great Lakes region of the United States. A relatively solitary species, *B. brevicauda* is commonly found in the Northeast region of the United States extending just into the southern border of Canada (Kurta 2017). These shrews can be found in damp areas of the forest or grasslands with plentiful herbaceous cover and forage usually shortly after sunset and right before dawn (Kurta 2017). What makes *B. brevicauda* unique is they are one of the few mammals in the world that is venomous. Their venom is used to incapacitate their prey, especially prey that may be larger than them like mice, in order to consume them more easily (George *et al*. 1986 and Kurta 2017).

B. brevicauda is known for its aggressive behavior. Many studies have described this behavior. In an experimental setting, the shrews almost always consume prey that is placed in front of them, such as spadefoot toads (Maier, T. J. 2005). However, it is unclear to what extent that *B. brevicauda* interacts and consumes these animals in the wild. The prey items of *B. brevicauda* include, but are not limited to, small rodents, insects, seeds, and snails (Kurta 2017). Because there are so many studies and accounts of *B. brevicauda* as predators, it is not often thought that these vicious animals in the context the prey of other predators.

Even the frightening *B. brevicauda* is eaten by many predators in the forest. This includes avian species like Great Horned Owls, snakes, and larger mammals like minks and weasels. In fact shrews along with voles, mice and muskrats are what comprise the American mink's (*Neovison vison*) diet. *N. vison* ranges all over the United States and Canada except the most Northern part of Canada (Kurta 2017). They forage within a home range that usually stays within sight of open water at night, especially near dawn and dusk (Kurta 2017). This overlaps with *B. brevicauda*'s habitat and foraging style. Though shrews and minks have a predator prey interaction in the wild, the interaction between these two species, particularly the antipredator behavior of *B. brevicauda* towards *N. vision*, is unknown.

The purpose of this study is to observe and score the behavior of *B. brevicauda* when presented with the scent of a predator, *N. vison*, and the scent of a control substance. If the shrew is exhibiting antipredator behavior, then I hypothesize that the shrew will spend the most amount of time away from the scent of *N. vision*. I would expect that shrews are less likely to explore near the predator scent.

Materials and Methods

Shrews were caught in the summer months of 2009. The shrews were individually placed in an aquarium. The aquarium was separated into three zones which were left, center, and right. 1ml of both urine of mink and water were placed on two cotton balls which were placed separately into two covered canisters with open holes to allow the scent to escape. Two canisters were placed in the aquarium, one in the left zone and the other in the right zone (Fig. 1). The canister with the urine of mink was randomly assigned either the left or the right zone and the water canister was placed in the opposite zone leaving the center zone clear. The shrew was video recorded for 30 minutes.

These videos were scored and analyzed using JWatcher. Behaviors that were recorded included exploring, motionless, and jumping behavior. Other behaviors were noted. These behaviors as well as the zone of the aquarium they occurred in were recorded. Exploring behavior was defined as any movement within the zone and between the zones made by the shrew as well as obvious twitching of the head that is recognized as scanning the environment. Motionless is defined as the shrew remaining in one position and not exhibiting any other behavior. Jumping behavior was defined as the shrew noticeably lifting all feet and body off of the surface. It is important to note that the observer was ignorant of which canister contained the urine of mink until the scoring was finished.

The behaviors scored were measured and analyzed for what zone they occurred in, the total time the behavior occurred, the number of times the behavior occurred, and the proportion of the video that the behavior occurred. The results were then entered into R to run the statistical tests. A paired t-test was used to compare the total time the shrew spent in the zone with the urine of mink and the zone that with the control substance, the total time spent exploring and the total time spent motionless, the number of times the exploring behavior was recorded in the zone with the urine of mink and the zone with the control substance, the number of times the motionless behavior was recorded in the zone with the urine of mink and the zone with the control substance, and the number of times the explore and motionless behaviors were recorded.

Results

There appears to be a slight difference in the amount of time the shrew spends on the zone with the urine of mink and the zone with the control substance (Fig. 2). The shrew spends a slightly longer time in the zone with the control substance than the zone with urine of mink, however, this difference is not statistically significant (mean total time spent in the mink scent zone= 281345.5 ± 73443.5 ms; mean total time spent in the control zone= 470638.2 ± 134793.2 ms; t = -0.77337, df = 15, p-value = 0.4513).

There is also a slight difference in the amount of time the shrew spends motionless and exploring (Fig. 3). While the shrew spends a little more time exploring than motionless, this difference is not significant (mean total time shrew spent motionless= 666392.5 ± 124845 ms ; mean total time shrew spent exploring= 1127252 ± 125915 ms ;t = -1.8381, df = 15, p-value = 0.08594).

Very little difference can be observed between the number of times the shrew was recorded exploring in the zone with the urine of mink and the zone with the control substance (Fig. 4). This difference is in fact not statistically significant (mean number of times shrew was recorded exploring in the mink scent zone= 33. 125 ± 10.07715 ; mean number of times the shrew was recorded exploring in the control zone= 30.9375 ± 7.200966 ;t = -0.49588, df = 15, p-value = 0.6272). A similar result can be seen in the number of times the shrew was recorded motionless in the zone with the urine of mink and the zone with the control substance (Fig. 5). There is no significant difference between the number of times the shrew was recorded in these two zones (mean number of times the shrew was recorded motionless in the mink scent zone= 6.8125 ± 1.678836; mean number of times the shrew was recorded motionless in the control zone= 5 ± 0.8990736 ;t = 0.42235, df = 15, p-value = 0.6788).

Though there was no significance in the total time the shrew spent exploring compared to the, however, the number of times the shrew was recorded to exhibit exploring behavior compared to the number of times the shrew was recorded to exhibit motionless behavior was significant (mean number of times the shrew was recorded exploring= 106.75 ± 28.23539 ; mean number of times the shrew was recorded motionless= 13.25 ± 1.129234; $t = 5.1493$, $df = 15$, p-value = 0.0001187). Shrews had more exploring bouts than remaining motionless (Fig. 6).

It is important to note that other behaviors were observed other than exploring and motionless. There were also burrowing, jumping, and attacking the container containing the urine of mink observed.

Discussion

Overall, my hypothesis that shrews would spend more time away from the urine of mink is not supported. The shrews did not have a particular side of the aquarium that they prefer since there was no significant difference between time spent on the side with the urine of mink and the side with the control substance. Shrews appeared to spend more time exhibiting exploring behavior than motionless behavior. Although the total time spent exploring and motionless was not significant, the shrews were significantly recorded exploring more times than recorded motionless. Some of the time the shrew was exploring it was trying to climb the walls of the aquarium and trying to get out. It is possible that the exploring behavior was the overall reaction to the urine of mink. However, the exploratory behavior can also be a result of the life history strategy of *B. brevicauda*. Previous studies indicate that shrews, in particular soricidae, show a higher amount of exploratory behavior in general due to their high metabolic rate and need for energy (Rychlik and Jancewiz 2002 and Von Merton and Siemers 2012). It is unclear to what extent the exploratory behavior exhibited in this study is a direct result of the predator scent and the shrews natural behavior. Therefore further research is needed to assess this.

Other behaviors observed were jumping, burrowing, and attacking of the container with urine of mink. Burrowing behavior is the digging motion of the shrew trying to burrow under the substrate in the tank. This also could have been a response to the urine of mink. Jumping was typically during the exploring behavior as the shrew was trying to jump out of the aquarium. The only behavior that was quite unexpected was the attacking of the container containing the urine of mink. This only occurred with two shrews. This is similar to the aggressive behavior that has been previously observed in response to prey and other shrews (Rychlik and Zwolak 2005). However, attacking a predator was not expected and could possibly be a last resort in response to predation. This could possibly be explained by personality variation within the sample population. More social species of shrews are known to have a difference in personality within the population (Von Merton *et al*, 2012). However, *B. brevicauda* are a more solitary species, so more research is needed to examine the cause of the attacking behavior.

The motionless behavior is similar to other antipredator behaviors that animals like mice exhibit (Gliwicz and Taylor 2002). This could possibly be the shrews trying to appear less noticeable in response to the scent of the mink. However, another possibility could be the shrew conserving energy. Shrews have an extremely high metabolism and they expel a lot of energy exploring, jumping, or borrowing. They do not depend on a photoperiod, or a specific time of day to determine when they are active since they need to forage and rest almost constantly (Brandt and McCay 2005). Therefore, there are two possibilities which are that the shrew exhibited motionless behavior which are to conserve energy, or to seem less mobile in case of predator presence. Because there is no significant difference between the time spent motionless in each of the zones, it is more likely that the shrew was resting rather than exhibiting antipredator behavior. This suggests that there is the possibility of a tradeoff between gaining and conserving energy and spending the energy in response to a predator. The behavior of the shrew could have been a natural response and not a response to the predator cue as their natural habits include periods of rest as well as periods of exploration in order to forage for food.

Therefore, the extent to which the behavior exhibited by the shrews is in response to the predator cue cannot be determined.

Further research is needed to determine the antipredator adaptations of *B. brevicauda*. First, there could be possible errors due to human error and missed behaviors as well as delayed responses during scoring the behavior of shrews. Another program that is more precise in scoring behavior should be used if the experiment is also replicated. The aquarium could have also been larger in order to allow for more movement between the zones. The extent of the senses of *B. brevicauda* have not been extensively researched and are not fully known. There is also the possibility that shrews use multimodal sensing. While there was the scent of the predator, other senses like sight and hearing could indicate to the shrew that there was no immediate danger. Therefore, further research on shrew sensing abilities such as the possibility of echolocation should be reviewed. Perhaps when replicating this experiment, a microphone can be placed in the aquarium with the shrew in order to record any changes in call structure in response to the predator scent or in exploring and motionless behaviors.

Overall, the behavioral response of *B. brecauda* in the presence of both the urine of mink and the control substance reveals little about their response to a predator. Though the shrew does seem to explore and try to escape more than it remains motionless, it is unclear to what extent this is an antipredator behavior and further research is needed to fully understand the antipredator behavior of *B. brevicauda*.

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Figure 1. Experimental setup. The shrew is place in the aquarium separated into three zones. In this image the shrew is currently in the central zone. The scent canisters are placed on the two end zones.

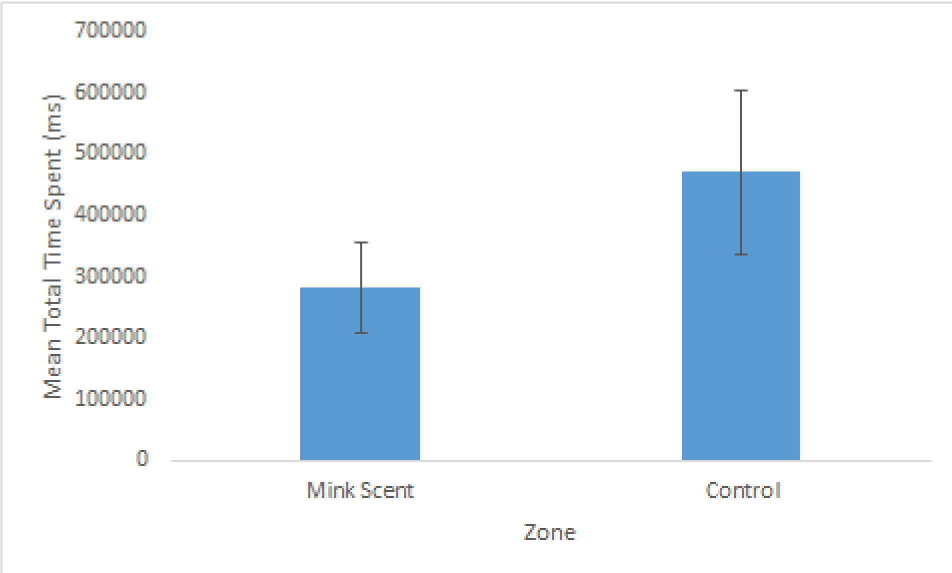

Figure 2. The mean time shrews spent in the zone with the urine of mink compared to the control zone (mean number of times the shrew was recorded exploring= 106.75 ± 28.23539 ; mean number of times the shrew was recorded motionless= 13.25 ± 1.129234; t = 5.1493, df = 15, p-value = 0.0001187).. The error bars reflect the standard error of the mean.

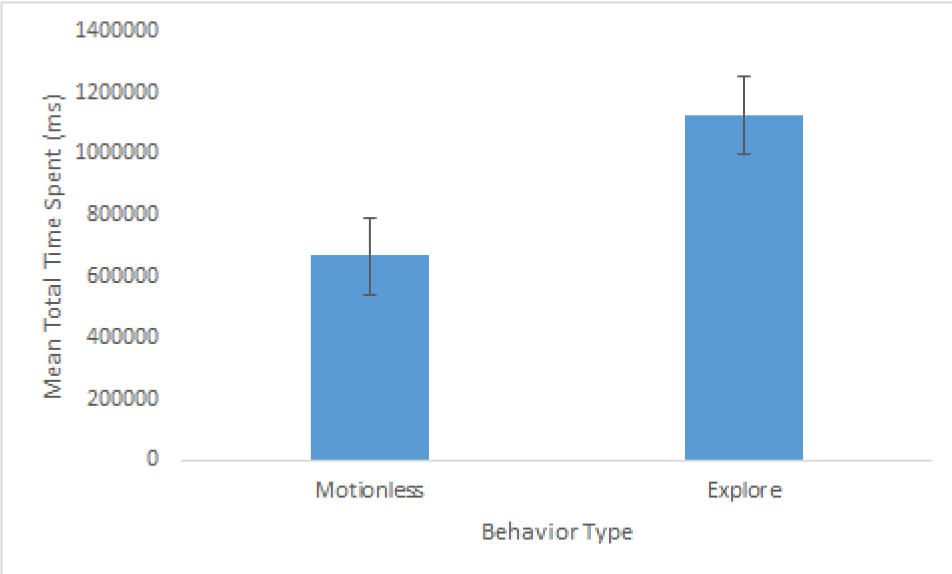

Figure 3. The mean time shrews spent motionless compared to exploring (mean total time shrew spent motionless= 666392.5 ± 124845 ms ; mean total time shrew spent exploring= 1127252 ± 125915 ms ;t = -1.8381, df = 15, p-value = 0.08594).The error bars reflect the standard error of the mean.

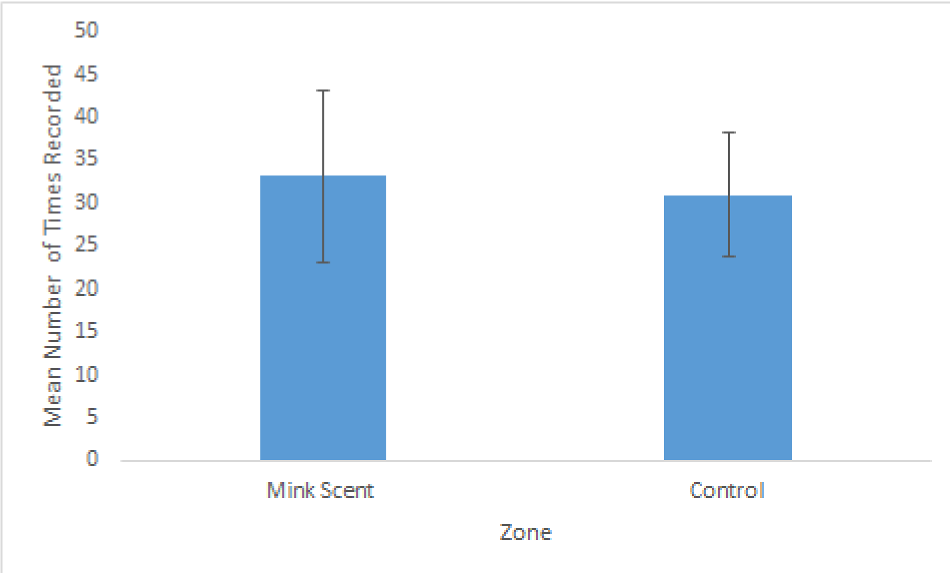

Figure 4. The mean number of times shrews spent exploring in the zone with the urine of mink and the control zone (mean number of times shrew was recorded exploring in the mink scent zone= 33. 125 ± 10.07715 ; mean number of times the shrew was recorded exploring in the control zone= 30.9375 ± 7.200966 ;t = -0.49588, df = 15, p-value = 0.6272). The error bars reflect the standard error of the mean.

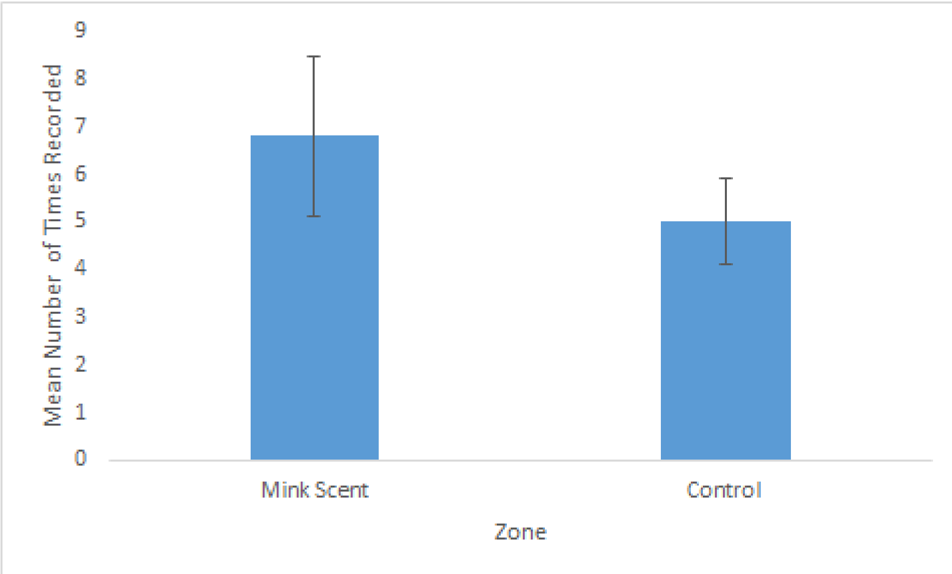

Figure 5. The mean number of times shrews spent motionless in the zone with the urine of mink and the control zone (mean number of times the shrew was recorded motionless in the mink scent zone= 6.8125 ± 1.678836; mean number of times the shrew was recorded motionless in the control zone= 5 ± 0.8990736 ;t = 0.42235, df = 15, p-value = 0.6788). The error bars reflect the standard error of the mean.

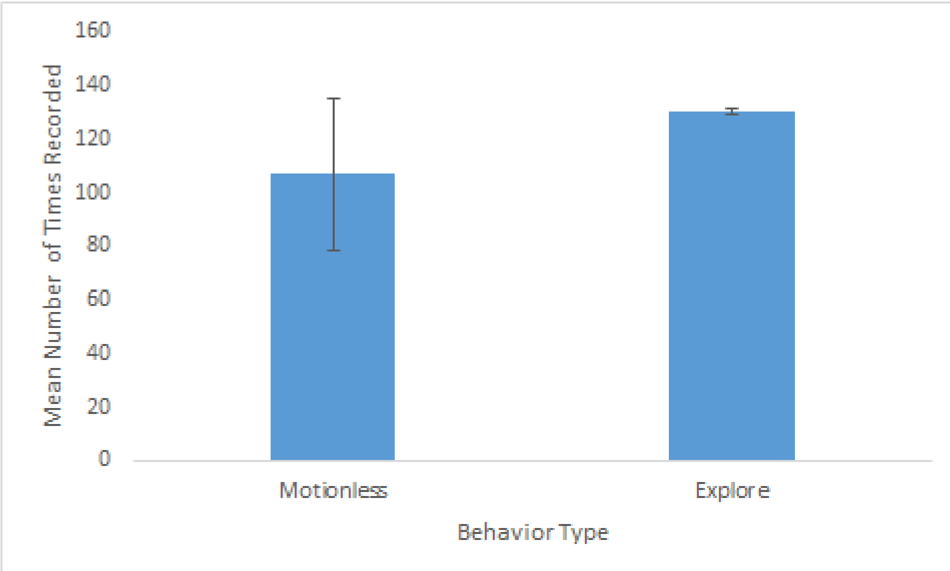

Figure 6. The mean number of times shrews were recorded motionless compared to exploring (mean number of times the shrew was recorded exploring= 106.75 ± 28.23539 ; mean number of times the shrew was recorded motionless= 13.25 ± 1.129234; t = 5.1493, df = 15, p-value = 0.0001187). The error bars reflect the standard error of the mean.