

FROM THE INSTRUCTOR

This paper would be an excellent model for any student writing a scientific paper with a similar structure and style, but since this kind of writing is not widely taught in our program, I will focus this guide on more broadly applicable elements. If you would like lessons geared to scientific writing or have questions about any other aspects of this guide, email me at hcschaaf@bu.edu

Abstracts

For Faculty: Emma's work could be combined with other abstracts from *WR* to help students analyze the structures of abstracts across different disciplines. This analysis addresses the abstract as a genre but also enables students to consider variations and commonalities in the structures of arguments across disciplines.

Some potential papers with abstracts that could be used include Issue 9's "Hwa-Byung: The 'Han' Blessed Illness" and "All Hammed Up: How *Hamilton: An American Musical* Addresses Post-Racial Beliefs," Issue 8's "When Awareness Is Not Enough: Trivialization of Women's Symptoms and the Gender Gap in the Outcomes of Cardiovascular Disease Patients," and Issue 7's "Painting the Real Picture: The Benefits of Autoethnographic Filmmaking for Children with Life-Threatening Illness."

For Students

Read each abstract sentence by sentence and take notes to answer the following questions:

1. Concisely describe the function and content of each sentence in the assigned abstracts.
2. What similarities do you see between the functions of particular sentences across abstracts? Do these sentences with similar functions appear at similar points or at different points?
3. What patterns do you see in the overall structures and sequences of material in the abstracts?
4. What variations in content, structure, and style do you see between the different abstracts? What factors cause these differences?

Standard Form Introductions

WR 120

For Faculty: Although it is an introduction for an advanced piece at the WR 150 level and so is lengthier than the introductions most students will write for their first academic papers in WR 120, the three parts of Emma's introduction would likely be possible for students to find in an activity when they were first introduced to the standard form introduction. The only aspect that is not completely straightforward involves background elements that appear after the question/problem, but this aspect can lead to fruitful discussions about order.

Even if your course does not focus on scientific papers, Emma's paper could be used in combination with other WR papers to show how the patterns of the standard form introduction hold across a variety of disciplines. Revealing this range through student work is helpful for showing that skills we teach are transferrable to a variety of majors.

Some potential introductions that could be used include Issue 11's "First Responders: The Evolution of Presidential Role and Rhetoric in the Era of School Shootings," Issue 10's "Fall'n in the practice of a damned slave': Racial Ideology and Villainy in Shakespeare's *Othello*," Issue 9's "The Benefits of Prison Nursery Programs: Spreading Awareness to Correctional Administrators Through Informative Conferences and Nursery Program Site Visits" and "The Grim Reality Hidden Beneath Freshkills Park's Bright Façade"

For WR 120 Students

1. Mark the parts of the introductions that you think are functioning as background. What aspects make you think they are serving this function?
2. Find the sentences that you think are functioning as a problem / question /destabilizing moment. How do the writers distinguish their arguments from the texts to which they are responding?
3. Find the claim / hypothesis.
4. After marking the parts that serve these different functions, consider the order of particular points in the introductions in more detail. How do the writers make transitions between background material, problem/questions, and claims, as well as between points within the background?
5. How does the type of exhibit the writers are using and the academic discipline in which they are writing affect specific features of the introductions?

WR 150s

For Faculty: At the 150 levels, the introduction could be explored even more as an opportunity to reflect on how research, reading, writing, and editing practices differ for varied audiences, genres, and purposes.

For Students

1. Mark the parts of the introduction that you think are functioning as background. What kinds of data and sources are the students introducing in the background and what do those ideas suggest about the writers' research procedures?
2. Find the sentences that you think are functioning as a problem / question /destabilizing moment. Where do the writers distinguish their arguments from the research to which they are responding? How do they define a niche for their research?

3. Find the claim / hypothesis.
4. After marking the parts that serve these functions, consider the order of particular points in the introductions in more detail. How do the writers make transitions between background material, problem/questions, and claims, as well as between points within the background?
5. How do the different types of research the writers conducted and the different academic disciplines in which they are writing create differences in content and structure between the introductions? What aspects of the structure are the same or similar across disciplines?

Acknowledgment and Response: The Effects of Paraphrase

For Faculty: Emma’s paper demonstrates several typical ways of acknowledging and responding to sources in a scientific paper. The acknowledgment emphasizes paraphrasing and summarizing findings rather than quoting specific points. Emma’s paper could be paired with a paper that primarily quotes previous research. A more elaborate exercise could compare four papers – two that use primarily paraphrase and two that use quotations from previous arguments.

Some papers that use quotations from arguments to which they are responding include Issue 10’s “‘Howl’ as Literary Montage: Cinema’s Influence on the Beat Generation” and “Representations of Mental Illness on FOX and CNN: The Parkland Shooting,” Issue 9’s “Minstrelsy and Brechtian Epic Theater: An Analysis of Satire,” and Issue 7’s “*Battlestar Galactica: A Vehicle of the American Road.*”

For Students

1. Find three instances of acknowledgment and response in each paper.
2. After analyzing each of these examples, generalize about the effects of acknowledging through quotation vs. paraphrase.
3. How does the choice of acknowledging through paraphrase or quotation affect the ways that writers respond to the material from previous research? Considered another way, what opportunities do quotation vs. paraphrase create for response?
4. What are the advantages and disadvantages of paraphrase vs. quotation depending on how you want to situate your argument in relation to others?

Genres: Organization and Argumentation

For Faculty: Even if your course does not feature scientific writing, Emma’s paper can help students accomplish two central goals for WR 120: crafting responsible, considered, and well-structured written arguments and reading a range of genres with understanding, appreciation, and critical judgment. Developing tools for understanding how and why arguments in particular genres and disciplines are structured in the ways they are allow students to comprehend and use the genres they need in the future.

For Students

1. “Responses of urban Eastern Gray squirrels (*Sciurus carolinensis*) to humans and conspecifics in an area of Boston Common” is divided into major sections which are further sub-divided. What are the effects of making divisions with headings in comparison to having an argument with no sections? How does the writer visually distinguish major sections from sub-sections?
2. As is the case with most original research in scientific disciplines, the major sections of the paper are Introduction, Method, Results, and Discussion. Describe what the primary function of each section seems to be, identify what features helped you figure out the purpose of that part, and suggest why you think a paper in the sciences would need a section that serves each function. How do sections with these particular functions help to advance a scientific argument?
3. Look at the Method, Results and Discussion sections and list the further sub-divisions of each. What are the functions of each of these sub-sections? How do they come together as a group to strengthen the structure and clarity of the specific major section of which they are a part?

Multimodality: Use of Visual and Spatial Elements

For Faculty: Emma’s paper uses two visual elements – a map and two charts – in order to present some of its data. Analyzing these elements would help with visual literacy and the study of multimodality even if your students are not writing scientific papers. The questions that follow are meant to be generally applicable.

For Students

- 1a. What purpose does the map serve? How does it help express similar information to some of the descriptions in the Method section?
 - b. What specific details does the map present and how are those details relevant to the argument? How does having a map help you as a reader to envision the site and what the writer is doing and arguing in ways that prose could not?
 - c. Based on your work with this example, brainstorm some types of information that maps convey persuasively and some contexts in which maps can help to advance an argument.
2. a. The writer presents two charts in her Results. How do you read the information on the charts differently than you would read the same data if it were presented in prose paragraphs?
 - b. Evaluate the sets of categories that each chart uses to organize its information. Do the categories work together to explain the focus of that chart? Is the sequence of the categories from left to right logical? Imagine that the order was shifted in various ways. How would the change in sequence affect your processing of the information?
 - c. Each of the charts has several categories with very few words but also has a final column entitled “Comments” which has more text than the other columns. Evaluate the decision to include this category/column in the charts. Is it too lengthy for the chart format in general? Why or why not? How does having these details juxtaposed to the shorter information affect how you read these

connections? What would be the effects if the writer had moved this longer information elsewhere and not included it in the charts?

d. Based on your analysis of charts in this paper, what types of information can charts convey effectively and what types of data do they communicate less effectively? How do the columns and structures of charts create relationships between the data presented in ways that prose paragraphs do not?

Organizing Annotated Bibliographies

For Faculty: In preparation for writing their own annotated bibliographies, students could analyze Emma’s organizational approach. I asked her to submit her annotated bibliography rather than the version with the references in alphabetical order because I felt that her groupings of sources might help students consider how annotated bibliographies can be brainstorming and organizational tools in addition to being finished products intended for readers’ guidance.

For Students

1. a. Describe the approach the bibliography uses to organize sources into sub-sections. What types of categories does the writer use to group the sources? How can this particular type of organization help the researcher structure her argument?

b. What are some other approaches that could be used to group sources to help brainstorm an argument? What types of relationships could you create between your argument and your chosen sources by sorting / classifying sources through particular categories?

2. Each annotation has two parts. Reading through the entries, what is the function of each part? How are each of those functions helpful for planning an argument based on relationships to a range of sources?

Place-Based, Outside-the-Classroom Learning: Inspiration for Boston Papers

For Faculty: Although it responds to larger research conversations about the Eastern gray squirrel and urban wildlife more generally, “Responses of urban Eastern Gray squirrels (*Sciurus carolinensis*) to humans and conspecifics in an area of Boston Common” relies on a specific Boston context. Emma’s research took place at Boston Common – one of the city’s oldest and most famous sites. Her paper could be explored on its own or read alongside Issue 5’s “Down the Street and Around the World: An Exploration of Everyday Exoticism in the Isabella Stewart Gardner Museum” if you are planning to have your students write papers in which they will engage with places outside the classroom in Boston by directly visiting them.

For Students

1. What kinds of strategies do the writers use for observing particular details of the specific Boston sites featured in their papers? How could you adapt these observational strategies in your Boston-based paper?

2. What different strategies and structures do the writers use to present their observations of the places in the papers? Which of these strategies and structures could you use in your paper?
3. How do the writers analyze the specific Boston sites they use as exhibits? What aspects of their approaches could you adapt to your analysis?
4. Compare the sentence-level writing styles of these two papers. What features of style from either could you adapt to your paper? What features do not seem apt for your paper?
5. In addition to the places analyzed, what other sources do the writers use in each paper? What aspects of their textual source-use could you adapt to your paper?

Holly Schaaf
WR 150: Writing, Research, & Inquiry

FROM THE WRITER

As a kid, I always loved being outside, climbing trees, adventuring through the woods, and watching wildlife. A slightly embarrassing early childhood video shows me attempting to converse with squirrels. I've always wondered what my dog and other animals were actually thinking. That's why I waited until the end of sophomore year when I was finally able to get into Professor Schaaf's "Imagining Animal Minds" WR 150 course. I had never written a scholarly research paper before, but Professor Schaaf's approach of sharing model articles, combined with ample opportunity to practice each step along the way, made the process much less intimidating. Inspired by one article that suggested a need for research on individuals within a population (rather than the typical urban versus rural comparison), I decided to study a particular group of squirrels who made the Boston Common graveyard their home. Like my younger self, I was able to sit amongst these furry-tailed friends and wonder about things like what made one shy and another bold. The skills I've learned in this course will guide me in future endeavors as a Speech-Language Pathologist. I can apply these new skills whether I am writing up clinical observations, conducting research in a lab, giving a presentation at a conference, or maybe even writing a children's book.

EMMA RADEMACHER is a rising junior in Boston University's Sargent College of Health and Rehabilitation Sciences, majoring in Speech, Language, and Hearing Sciences. She grew up in Rhode Island, and was a competitive figure skater for 12 years. She continues her career on the ice as a member of BU's Synchronized Skating team. In addition, Emma enjoys working with children, painting, drawing, and playing the piano, and has climbed Mt. Washington five times. She would like to thank her WR 150 professor, Holly Schaaf, for being so supportive and helpful throughout the entire revision process, and always providing lengthy, insightful responses to her emails.

EMMA RADEMACHER

Tony Wallace Award for Writing Excellence

RESPONSES OF URBAN EASTERN GRAY SQUIRRELS (*SCIURUS CAROLINENSIS*) TO HUMANS AND CONSPECIFICS IN AN AREA OF BOSTON COMMON

ABSTRACT

Urbanization is rapidly forcing species into different habitats and affecting the way they interact with humans and conspecifics. Studies have explored the large-scale differences between urban and rural species, but have neglected the differences among individuals within populations. This study focuses on the behaviors of a population of Eastern Gray squirrels in the Boston Common Central Burying Ground. I investigated how these urban squirrels responded to humans through habitat selection, boldness, and vigilance, and to conspecifics through social learning and aggression. I hypothesized that the squirrels found in northern areas will be bolder and less vigilant than squirrels found in the southern quadrants. To test my hypothesis, I made qualitative observations regarding the squirrels' behaviors, then conducted quantitative studies on the squirrels' boldness and vigilance. To test vigilance, I measured flight initiation distance (FID). To test boldness, I recorded the time it took for each squirrel to obtain an almond from me. My results supported my hypothesis, showing that squirrels were bolder and less vigilant in the northern quadrants than in the southern quadrants. These results can be explained by habituation to humans, density of conspecifics, and canopy cover.

INTRODUCTION

As the world is becoming more urbanized, various species can be found in locations very different from their native rural environments. Prior studies have found that urbanization can lead to heightened neophilia, boldness, and aggression in some species (Barrett et al. 2018). In their 2010 book chapter "Urban Wildlife Behavior," Amy M. Ryan and Sarah R. Partan explore some of the behaviors of urban animals responding to increased exposure to humans. In many urban species, one of these behaviors can be higher tolerance for humans, as measured by shorter flight initiation distances (FID), or the distance at which an animal changes its behavior as a human approaches it. The Eastern Gray Squirrel is one species whose urban groups have shorter FIDs than their non-urban counterparts (Cooper et al. 2008).

While there are many animal behavior studies like Cooper et al. (2008) which focus on large-scale differences between urban and rural populations, most studies ignore differences in behavior among individuals within a population (Ryan and Partan 2010). In addition, Ryan and Partan (2010) note that the effects of urbanization on social behavior is an area in need of research. This study

aims to address these gaps by studying the behaviors of a population of Eastern Gray squirrels inhabiting a section of an urban park in Boston.

Boston Common is a 50-acre urban park in the center of Boston that attracts hundreds of thousands of people every year. Founded in 1634, the Common's history began as a gathering spot during the Revolution ("Boston Common"). The Central Burying Ground, located in the southern section of the park, is home to the graves of many historical figures as well as a dense population of squirrels that enjoy daily human feeding.

I observed this group of squirrels on three occasions in March 2019 and recorded my observations of their boldness, vigilance, foraging, response to human movement and sound, and social behaviors. In addition, I conducted tests to measure their boldness and vigilance in response to my actions. My study will address how the behavior of urban Eastern Gray squirrels in the Central Burying Ground of Boston Common varies as they respond to human visitors and conspecifics. I predict that most of the squirrels in the Central Burying Ground will be found in the northern quadrants of the cemetery due to habitual human feeding and greater canopy coverage there. The squirrels found in these areas will be bolder and less vigilant, on average, than the squirrels found in the southern quadrants of the cemetery; however, among individual squirrels in the northern quadrants there will be a range of temperaments, with shyer squirrels learning from bolder ones.

METHOD

Study Area

The Central Burying Ground is bordered by Boylston Street to the South, Tremont Street to the East, and Charles Street to the West. This area is home to many Eastern Gray squirrels, as it contains many trees and is protected by a tall fence.



Observation Locations

- | |
|----------------------|
| 2 Grassy Triangle |
| 3 Northwest Quadrant |
| 4 Northeast Quadrant |
| 5 Southwest Quadrant |
| 6 Southeast Quadrant |

Grassy Triangle

This space is mostly hard dirt closest to the fence, then becomes grassier closer to the walkways. The fence between the Grassy Triangle and the northeast and northwest quadrants is a barrier between the majority of the squirrels and the people, but quite often people feed squirrels there. Many squirrels venture past the fence to be fed by people or to forage on their own.

Northeast Quadrant

The Northeast quadrant is bordered by a walkway on the east side, and a grassy patch on the north side and has a canopy cover of almost 100%. Most squirrels gather here.

Northwest Quadrant

The Northwest quadrant is bordered by a walkway on either side. There is less green space outside the fence surrounding this quadrant as compared to the amount of green space outside the fence surrounding the Northeast quadrant. The Northwest quadrant has a canopy cover of 40%. This area contains the second highest amount of squirrels.

Southeast Quadrant

The Southeast quadrant is bordered by a walkway to the east and Boylston Street to the south. Canopy cover of this quadrant is about 75%. Not many squirrels populate this area. This quadrant has significantly more noise pollution than the Northwest and Northeast quadrants due to its proximity to Boylston Street.

Southwest Quadrant

The Southwest quadrant is bordered by a walkway to the west that contains little human traffic, as well as Boylston Street on its south side. A small gorge separates the majority of the green space from the fence. There is about 25% canopy coverage. There are fewer squirrels.

PROCEDURES

Observations

The first study involved observing squirrels from the Grassy Triangle to the north of the Central Burying Ground. I observed on three different dates in March 2019, one week apart, between the hours of 12:00 p.m. to 3:00 p.m. for periods of 20-60 minutes. Behavior was recorded in a computer roughly every minute and each observation was categorized as Vigilance (V), Boldness (B), Feeding (F) or Other (O).

Vigilance Study

To determine vigilance, I measured flight initiation distance (FID) in a manner consistent with Cooper et al. (2008). I began in the Northeast Quadrant, selected one squirrel at least 10 feet away, walked at a slow, steady pace, with my arms by my side, a blank facial expression, making no sound, with a gaze focused on the squirrel. Once the squirrel turned in the opposite direction and started to run away, I measured the distance between myself and the location at which the squirrel fled, making note of any other behaviors the squirrel exhibited. I repeated this process for another squirrel in the same area, and then for two different squirrels in every other quadrant.

Boldness Study

To measure boldness, I placed myself first in the Grassy Triangle. I sat with almonds in my hand or directly next to me. The goal was to get the squirrel to obtain the nut, whether it were in my hand or beside me, but the way in which the squirrel obtained the nut was taken into consideration when quantifying its boldness. I began a stopwatch when I was able to get a squirrel's attention. I sat with my legs crossed, waited, and ended the stopwatch once the squirrel obtained the nut. I repeated this process for two squirrels in each quadrant and in the Grassy Triangle. I made note of specific behaviors of each squirrel as it approached me.

RESULTS

QUALITATIVE RESULTS

Qualitative Observation Details Observations were recorded and coded in a spreadsheet which can be found in the file labeled “Squirrel Observation Details.”

Response to Humans

Foraging Locations

Most squirrels present during my observation periods foraged in the northern quadrants of the burial ground and in the Grassy Triangle. About 90% of the total squirrels in the graveyard were in the northern quadrants and 10% in the southern quadrants. When given food from humans, squirrels most often went back through the fence to eat or bury the nut inside the graveyard. When foraging on their own, most squirrels stayed within the northern sections of the graveyard; only a few squirrels would occasionally venture outside the graveyard to forage in the Grassy Triangle. When a person left a pile of nuts on the ledge surrounding the burial ground, usually no more than three squirrels at a time gathered around the pile.

Vigilance

Squirrels responded with greater vigilance to humans that were noisier and made quick, large movements. A man trying to feed a squirrel in the Grassy Triangle right outside the Northeast Quadrant was talking loudly and continuously. The squirrel he was trying to feed was cautious in approaching him—it would approach a few feet, then freeze on all fours when the man tried to move closer to it. After three minutes, the squirrel took the nut from the man’s hand.

When I sat quietly on the Grassy Triangle between the Northeast and Northwest Quadrants, some squirrels would pause on all fours to stare at me from about 15 feet away on the ledge surrounding the burial ground. When I shook the bag of almonds to get a squirrel’s attention, a few squirrels would either freeze or flee. A few of the squirrels flicked their tails and stared at me if I got too close, made too loud a noise, or made too quick a movement.

Boldness

Overall, squirrels responded with greater boldness when I sat still and made quiet but repetitive kissing or clucking sounds. I observed that most squirrels also responded positively to the shaking of a bag of almonds, followed by an outstretched hand. If I sat still outside the graveyard in the Grassy Triangle with almonds in my hands about 95% of squirrels would approach me and take a nut from my hand. Squirrels in the Grassy Triangle and the northern quadrants were quicker to take nuts from my hands than squirrels in the southern quadrants.

Squirrels were unafraid of human possessions, such as my backpack and laptop. As I was typing notes, about one to two squirrels every two to three minutes would approach my laptop. While I was paying no mind to the squirrels and typing up observation notes, a few squirrels crawled under my crisscrossed legs to stick their heads into the bag of almonds.

Response to Conspecifics: Social Learning and Aggression

On several occasions, onlooking squirrels appeared to copy the behavior of bolder conspecifics. When I sat still, a squirrel would cautiously approach my hand, but eventually obtain the nut. Another squirrel nearby observed this behavior and approached me, looking for another

nut, only a few seconds afterwards. While sitting in the Grassy Triangle, I observed similar behavior, even without nuts.

A sudden abundance of food in any particular area created aggression amongst the squirrels. Within the northern quadrants, squirrels would often chase each other away while foraging. Similarly, if a human placed a pile of nuts on the ledge surrounding the burial ground, about three squirrels would approach the pile, and they would each try to chase the other away so that they could return to the pile and eat by themselves.

QUANTITATIVE RESULTS

Vigilance Study Results

My results indicate a significant difference in FID between squirrels in the northern and southern quadrants.

Figure 1: Vigilance Study Results from 3/31/19

Squirrel	Section of Site	FID (feet)	Comments
Squirrel A	NE	2 ft	Squirrel approached me as I approached it, backed away a few inches as I got closer, by the time I reached 2-ft distance it froze on all fours then turned around and darted up a tree
Squirrel B	NE	1 ft	Squirrel stood up on hind legs when I approach 1-ft distance, flicked tail, backed up, jumped on ledge and ran opposite direction
Squirrel C	NW	3 ft	Squirrel more towards center of NW section, was on tree when I reached 3-ft distance, froze for about 5 seconds, darted up tree
Squirrel D	NW	3 ft	Squirrel would back off as I got closer, I would slow down, squirrel would inch closer, cautiously, then I reached up to scratch my arm and it turned around and slowly hopped in opposite direction
Squirrel E	SW	6 ft	Squirrel more in open area of SW section, maybe felt unsafe without tree nearby, did not approach me, kept moving away as I got closer then ran to tree, flicked tail once it was halfway up the trunk

Squirrel F	SW	4 ft	Approached squirrel at base of tree, squirrel and I circled base of tree for a few seconds, then it darted up tree
Squirrel G	SE	10 ft	Squirrel did not freeze at all, just slowly hopped away as I approached at 10 ft
Squirrel H	SE	7 ft	Squirrel slowly hopped away as I approached it, did not look at me

Boldness Study Results

My results indicate a significant difference in average time for squirrels to obtain a nut between the northern and southern quadrants. In the northern quadrants, squirrels took, on average, 36.25 seconds to obtain a nut. In the southern quadrants, squirrels took 57.5 seconds to obtain a nut, on average.

Figure 2: Boldness Study Results from 3/31/19

Squirrel	Section of Site	Time to get Nut (in minutes and seconds)	How Close?	Behavior Comments
Squirrel A	NE at ledge outside fence	0:10	Took nut out of hand sitting atop my lap	Started from ledge 3 ft away, back up, approach a few inches, back up, approach, then extend neck and body, quickly grab nut, jump onto ledge to eat nut
Squirrel B	NE inside graveyard	0:16	Took nut out of hand sitting atop my lap	Approached right after squirrel A, same behavior as Squirrel A
Squirrel C	NW at ledge outside fence	0:37	Took nut out of hand extended as far away from my body as possible, hand resting on ledge	Saw hand holding nut from about 20 ft away, on ledge, would move about 2-3 ft before freezing on all fours (vigilance), look at me, then approach again after waiting 5 sec, steadily and slowly walk to hand then grab nut with paws and eat it 2 in from my hand

Squirrel D	NW inside graveyard	1:22	Took nut out of hand resting next to body	Got squirrel's attention by making clicking/kissing noises, stopped once squirrel saw nut, hopped over slowly and steadily, at 1 ft, would extend body, retreat, flick tail, make chattering noises, then extended body and grabbed nut out of hand, ran away, buried nut next to gravestone
Squirrel E	SW inside graveyard, next to tree	3:00	Took nut next to me about 1 ft away	Squirrel on tree trunk facing up, got squirrel's attention with clicking/kissing sounds, squirrel paused in downward position on tree trunk for 7 seconds, then scurried down and slowly approached me, I put nut on ground, squirrel paused, twitched tail, chattered, then grabbed nut and ran back up tree to eat nut on branch
Squirrel F	SW inside graveyard, next to same tree	0:31	Took nut from beside me 1 ft away	Squirrel on other side approached more confidently after seeing other squirrel take nut, but paused a foot away, looked at me, flicked tail, then grabbed nut and hopped away 15 feet to eat nut atop gravestone
Squirrel G	SE towards center of graveyard	0:14	Took nut from hand	Made kissing sounds to get attention, squirrel steadily approached hand, sniffed it, gently took nut with outstretched neck and body, ate nut next to my hand
Squirrel H	SE towards center of graveyard	0:05	Took nut from hand	Approached hand right after squirrel G got nut, flicked tail, looked at me, took two nuts and ran away

DISCUSSION

Habitat/Foraging Location

My study contributes to the existing literature of how habitat suitability and human habituation impact the foraging and habitat selection of urban Eastern Gray squirrels. My results indicate that, despite their proximity to heavy human foot traffic, the Northern quadrants of the Central Burying Ground are a preferred foraging location for squirrels in Boston Common. Several

prior studies provide possible explanations for this preference. A 2008 study found that canopy cover is a crucial determining factor for where squirrels choose to reside (Parker and Nilon 2008). Another study suggests that squirrels can habituate to humans and associate them with food. The risk-allocation hypothesis (Cooper et al. 2008) predicts a decrease in anti-predator behaviors in areas with high levels of human activity (discussed below), and an increase in habituation towards human feeding. Furthermore, while repeated exposure to the sights and smells of humans can lead to either sensitivity or habituation towards humans, species living in urban environments are more likely to become habituated to humans rather than avoidant of them (Barrett et al. 2018).

These studies support the claim that the Central Burying Ground squirrels have chosen the northern foraging location for its canopy coverage and due to their habituation toward human feeding. However, since the current study area has several features which seem to make it desirable for squirrels, it is not possible to isolate the impact of each feature. A future area of research could be how human structures and barriers such as the iron fencing around the graveyard impact gray squirrel foraging location selection.

Response to Humans: Vigilance and Boldness

While most studies of urban gray squirrels compare their vigilance and boldness behaviors to those of their rural counterparts (Barrett et al. 2018; Nowak et al. 2018), the current study takes a closer look at the vigilance and boldness behavior within a single group of urban squirrels. My results show that within the Central Burying Ground group, vigilance behavior varied by location in the graveyard with squirrels in the north exhibiting greater boldness and less vigilance than squirrels in the south. Previous studies on human habituation, conspecific density, and canopy coverage offer several possible explanations for this variance. Future studies would be needed to isolate each of these variables to determine which has the greatest impact on boldness and vigilance.

Human Habituation

One possible explanation for the variance in behavior could be that the squirrels in the Central Burying Ground are behaviorally flexible in response to varying conditions in each part of the graveyard. This may be because they have learned through experience that humans in the north are generally not threatening and are sources of food, whereas they have less experience with human behavior in the southern part of the graveyard. A study by Nowak et. al. (2018) found that urban squirrels have lower giving-up densities (GUDs) than their rural counterparts, suggesting that the more exposure squirrels have to humans, the less wary they become in their presence. In addition, a study of rainbow trout sought to determine whether their behavior was consistently bold or shy (i.e., “domain-general,” as in humans), or whether their behavior was context-specific. The study found that shyness and boldness in rainbow trout depended on context (Wilson and Stevens 2005). Perhaps the squirrels in the current study have learned to associate comfort around humans with the specific location in which it occurs, and do not generalize about all humans in all locations. However, further study of the squirrels would be needed to determine whether the same squirrel behaves differently in different parts of the graveyard, or if it is uniformly bold or shy throughout the cemetery.

Density of Conspecifics

Another explanation could be that the squirrels are bolder and less vigilant when there are higher densities of squirrels, such as in the northern quadrants. A previous study suggests that when squirrel density increases, wariness decreases and intraspecific boldness and aggression increases

(Parker and Nilon 2008), supporting the idea that the higher density of squirrels in the northern quadrants would be cause for higher levels of aggression there.

Canopy Coverage

The squirrels' variance in boldness and vigilance behavior can also be explained by the amount of canopy coverage in each section. Since the canopy coverage is much less in the southern quadrants, the squirrels may have left more distance between humans and themselves because of greater distance from a tree, perceived by squirrels as a guaranteed escape route. Previous studies have supported this idea, stating that squirrels have positive associations with high levels of canopy coverage, as it provides shelter and safe places to forage (Shuttleworth et. al. 2016). Parker and Nilon also found that canopy coverage is a major predictor of squirrel wariness as well as squirrel population density, thus also explaining why squirrels congregate more in the northern quadrants. They claim that more canopy coverage allows squirrels to be less wary, as it provides protection against predators (Parker and Nilon 2008). The results of these studies and the current study ultimately suggest that greater canopy coverage allows for squirrels to be bolder.

Response to Human Movement and Sound

The current study contributes to the existing literature that shows varied animal responses to human movement and sounds.

Movement and Gaze

Overall, squirrels were bolder when I sat still and did not engage in direct eye contact with them. Previous studies offer possible explanations for the squirrels' inquisitive behavior. Barrett et al. (2018) claim that bolder individuals are more likely to become habituated to the presence of humans, also making them more likely to engage in riskier behaviors, such as stealing anthropogenic food. It is possible that the squirrels have learned that certain body movements or direct eye contact indicates a threat. Similarly, Marzluff (2010) found that crows rely on cues from conspecifics and heterospecifics to gather information about threatening humans (Barrett et al. 2018). In addition, Zou et. al. (2014) found that monkeys associate direct eye contact with an unfamiliar human as threatening.

Sound

My results also showed that the squirrels in the study area were attracted to some human-made sounds and repulsed by others. Human kissing or clucking sounds attracted bolder squirrels, and even encouraged squirrels that were exhibiting the highest degrees of vigilance. This could be because the squirrels associate humans that make these noises with sources of food. Each time I made a kissing sound, I followed through with an outstretched hand and a nut.

However, other sounds, such as loud talking or laughing, deterred the squirrels. One such instance includes the squirrels' interactions with the noisy man standing on the Grassy Triangle outside the northeast quadrant. According to prior studies done by Levey et. al. (2009) and Vincze et al. (2015), discrimination learning allows species to avoid particular humans with whom they have had unpleasant experiences in the past (Barrett et al. 2018). Perhaps the noisy man had been to the cemetery before, causing a commotion, and leading the squirrels to believe he was a potential threat. Belguermi (2011) and Stephan (2013) also identified several studies in which some species can

identify and remember particular humans by their facial features or by their particular behaviors (Barrett et al. 2018).

Other human-made sounds could be affecting the squirrels in the cemetery. Lower squirrel density in the southern quadrants could be attributed to higher levels of noise pollution, since the southern quadrants are bordered by Boylston Street. Similarly, Duarte et. al. (2012) found that urban marmosets avoid areas with heavy sound pollution (Barrett et al. 2018).

Response to Conspecifics: Social Learning and Aggression

This study also contributes to prior research on the social behavior of urban animals foraging in groups.

Social Learning

My results showed that shyer on-looking squirrels seemed to learn from bolder squirrels how to safely obtain food. These results add to previous studies which show social learning among urban squirrels and other species. One study found that red squirrels can learn new feeding techniques from a more experienced squirrel and that this new knowledge persisted even after the model squirrel was no longer present (Weigl and Hanson 1980). However, another study found that squirrels learn even more effectively when observing a conspecific fail, rather than succeed, at a task (Hopewell et al. 2009). Hopkins (2013), Mazur and Seher (2008), and Breck et al. (2008), have done studies of other species including the black bear and jackdaws, which have found that these animals also learn from each other how to forage on anthropogenic food (Barrett et al. 2018). Future studies could investigate whether bolder squirrels, like the ones in the current study doing the “teaching,” are the parents of the shyer individuals, or whether shyer adult squirrels typically learn from bolder adult conspecifics.

Aggression

My results showed that intraspecific aggression increased in an area of high squirrel density when anthropogenic food was introduced. This finding is consistent with a study by Parker and Nilon (2008) which found an increased squirrel density contributes to decreased wariness and a more competitive drive for survival, thus creating more opportunity for aggression amongst squirrels. However, another study found that an increase in squirrel density leads to a decrease in squirrel aggression (Haigh et al. 2017). Since my study added the variable of anthropogenic food, this could explain the differing results. Future studies could examine the impact of density and human feeding on squirrel aggressiveness with a larger sample size of squirrels. In addition, future work could expand on this research by exploring the levels of aggression in squirrels when the density of humans or heterospecifics increases or decreases.

CONCLUSION

Limitations

There were various aspects of my study that may have been cause for error. I was inconsistent in how I executed the boldness study. For some squirrels, I held the nut in my hand, while for others, I placed the nut on the ground beside me. Furthermore, I made repetitive kissing

and clucking sounds for some squirrels, but not for others. Another point of error in my study could have resulted from too few trials. My results would need a larger sample size to be statistically significant. Additionally, since I returned to the cemetery three times and stayed for several hours each time, the squirrels may have habituated to me, and grown bolder in the process. Finally, when I quantified the number of squirrels that appeared bold or vigilant, I may have recounted squirrels.

Areas for Future Research

Future studies could address the limitations above through larger sample sizes, more trials and more standardized procedures for interacting with the squirrels. Additionally, squirrels could be tagged to determine whether they are consistently bold or shy, or whether their behavior is context-specific. Future projects could also attempt to isolate human habituation and canopy coverage to determine which has the greatest impact on boldness and vigilance. And finally, future studies could investigate whether bolder squirrels, like the ones in the current study doing the “teaching,” are the parents of the shyer individuals, or whether shyer adult squirrels typically learn from bolder adult conspecifics.

The current study shows a range of behaviors within a small group of urban squirrels and suggests that these differences may be due to fairly subtle changes in the landscape and in human-animal interactions. Studies on individual urban populations are important because they are a starting point to help us enhance conditions for both humans and wildlife in specific urban locations.

REFERENCES

General Information

Barrett, Lisa P., et al. "The Cognition of 'Nuisance' Species." *Animal Behaviour*, Vol. 147, 2019, pp. 167–177., doi:10.1016/j.anbehav.2018.05.005.

This article is a review of the special cognitive abilities of species which typically come into conflict with humans and are therefore called a "nuisance." These abilities include boldness, categorization, innovation, memory, learning, social learning and behavioral flexibility. This article will give me good definitions of behaviors and help me locate other studies which address vigilance and boldness. The sections on boldness, learning and social learning will be helpful to understanding the possible relationships between habitual human feeding and squirrel cognition, temperament and behavior.

"Boston Common." *Boston.gov*, 19 June 2018, www.boston.gov/parks/boston-common.

This site provides general information as well as a brief history on Boston Common. I used this source for background on Boston Common in my introduction.

Partan, Sarah R., et al. "Wild Tree Squirrels Respond with Multisensory Enhancement to Conspecific Robot Alarm Behaviour." *Animal Behaviour*, Vol. 77, No. 5, 2009, pp. 1127–1135., doi:10.1016/j.anbehav.2008.12.029.

In this experiment, a mechanical robot squirrel was programmed to mimic squirrel tail flags and alarm barks so as to test squirrel responses in both urban and rural environments. The study found that the squirrels responded most when both tail flags and alarm barks were combined rather than isolated, and that urban squirrels were more responsive to the tail flags, suggesting that the noise of an urban environment might be causing a shift to multimodal or visual cues rather than solely acoustic ones. This study is useful background to aid in the understanding of the effect of urbanization on squirrels.

Ryan, Amy M., and Sarah R. Partan. "Urban Wildlife Behavior." *Urban Wildlife*, 2014, pp. 149–173., doi:10.1007/978-1-4899-7500-3_9.

In this chapter of the book *Urban Wildlife Conservation: Theory and Practice*, authors Ryan and Partan outline many of the ways in which animal behavior changes due to urbanization. These areas include animal movement and home ranges, use of human structures, foraging behavior, anti-predator behavior and response to humans, social behavior, and animal communication. The authors conclude with a look at behavioral flexibility and the evolutionary implications of the effects of urbanization. This article is useful in my project because the sections on anti-predator behavior and response to humans, as well as on behavioral flexibility, reference several studies which can help me determine my specific focus and provide background information.

Habitat Selection

Merrick, Melissa, et al. "Urban Gray Squirrel Ecology, Associated Impacts, and Management Challenges." *The Grey Squirrel: Ecology & Management of an Invasive Species in Europe*, edited by Craig M. Shuttleworth, Peter W.W. Lutz, and John Gurnell. European Squirrel Initiative, 2016. pp. 57–77.

www.researchgate.net/publication/311733852_Urban_Gray_squirrel_ecology_associate_impacts_and_management_challenges.

In this book chapter, the author looks at the ecological characteristics of urban and rural squirrel populations, ecosystem functions and services of urban gray squirrels, the ecological impacts of urban gray squirrels on native fauna, and the management and control of urban gray populations. The authors consider it important to study urban gray squirrels to allow predictions of their behavior in new urban environments and to allow development of effective wildlife management strategies. This chapter is relevant to my study of Boston Common squirrels because it examines the impact of different habitat features, such as canopy coverage, on population density.

Parker, Tommy S., and Charles H. Nilon. "Gray Squirrel Density, Habitat Suitability, and Behavior in Urban Parks." *Urban Ecosystems*, Vol. 11, No. 3, 2008, pp. 243–255., doi:10.1007/s11252-008-0060-0.

This paper explores the relationship between gray squirrel density, intraspecific aggression, and boldness and habituation to human presence in various parks. This article measured these variables in Lafayette Park in Washington D.C., as well as in six other urban parks in Baltimore, MD. Ultimately, the study found that there is a positive relationship between squirrel density and intraspecific aggression, and a negative relationship between density and wariness. This research is helpful for my current study because it will provide support for my hypothesis.

Response to Humans

Bowers, Michael A., and Bianca Breland. "Foraging of Gray Squirrels on an Urban-Rural Gradient: Use of the GUD to Assess Anthropogenic Impact." *Ecological Applications*, Vol. 6, No. 4, 1996, pp. 1135–1142., doi:10.2307/2269597.

In this experiment, squirrels were given trays of sunflower seeds at seventy-eight sites in Virginia. Giving-Up Density, or GUD was measured by counting the number of seeds left after a period of time. Researchers found that the lowest GUDs occurred in urban areas near human structures, suggesting that either squirrels have reduced predatory fear of humans or that they have limited access to food in urban areas and are more hungry and willing to expose themselves. They also had lower GUDs when there were higher squirrel densities and greater canopy cover, suggesting that the squirrels fear predators less when there are more of them and they have an easy escape route up a tree. This study is relevant to my study of vigilance and boldness of squirrels.

Cooper, Christopher A., et al. "Behavioral Responses of Eastern Gray Squirrels in Suburban Habitats Differing in Human Activity Levels." *Northeastern Naturalist*, Vol. 15, No. 4, 2008, pp. 619–625., doi:10.1656/1092-6194-15.4.619.

This article written by Cooper et. al explores the responses of squirrels when approached by a human only and a human with a dog in areas with high and low levels of human activity. The authors conclude that alert distance in squirrels overall does not vary between human alone and human with dog approaches, but anti-predator behavior is influenced by the

presence of humans in the area. This article will be helpful as I am also studying vigilance behavior in the squirrels on Boston Common.

Nowak, Ted, et al. "Shyness and Boldness in Squirrels: Risk-Taking While Foraging Depends on Habitat Type." *Eukaryon*, Vol. 14, Mar. 2018.

This article examines the levels of shyness and boldness in squirrels at various locations, including urban, forest, and rural environments by measuring Giving-Up Density (GUD). The research found that squirrels in open environments were more likely to experience higher GUDs, and that urban squirrels experienced the lowest GUDs across distances of 5, 10, and 15 feet. The report attributes the cause of this to the high level of human activity in any environment would make squirrels more habituated to the presence of humans, or even make them see humans as a source of food. This research is relevant to my paper because I am also examining the level of boldness and vigilance in squirrels in an urban environment. This article will help me support my hypothesis.

Wilson, Alexander D. M., and E. D. Stevens. "Consistency in Context-Specific Measures of Shyness and Boldness in Rainbow Trout, *Oncorhynchus Mykiss*." *Ethology*, Vol. 111, No. 9, 2005, pp. 849–862., doi:10.1111/j.1439-0310.2005.01110.x.

This study asks whether rainbow trout are consistently bold or shy (domain-general) or whether their behavior is context-specific. The authors found that bold trout were consistently bold when the context was foraging, but that when exploring a swim flume, their behavior varied. The authors concluded that rainbow trout shyness and boldness depends on the context they are in. This research is relevant to my study of squirrel boldness and could also provide ideas for future methods of squirrel boldness/shyness research.

Zou, Hong, et al. "Differential Behavior Patterns in Cynomolgus Monkey *Macaca Fascicularis* in Home Cage in Response to Human Gaze." *Journal of Medical Primatology*, 2 Dec. 2014.

In this experiment, monkey behavior was analyzed when a human observer gazed at them and looked away. Various response behaviors were recorded such as opening/closing mouth, agitation, staring back and approaching the observer. The study found that the monkeys exhibited heightened awareness while being gazed at by the humans. They had longer durations of the measured behaviors when being gazed at. Similarly, during my study, the squirrels at the Central Burying Ground reacted with vigilance or fear when I fixed my gaze upon them.

Response to Conspecifics

Haigh, Amy, et al. "Variations in Aggression and Activity Levels amongst Squirrels Inhabiting Low and High Density Areas." *Ecological Research*, Vol. 32, No. 6, 2017, pp. 931–941. doi:10.1007/s11284-017-1506-8.

This study used radio tracking of squirrels and examined the effects of squirrel density on activity and aggression, survival probability, breeding and body condition. The researchers found that in areas of high squirrel density, the squirrels were less aggressive than their counterparts in areas of low density. There was also a significant correlation between the activity level of the squirrels and their aggressiveness. This study is relevant for my project because I too am looking at the relationship between squirrel density and aggressiveness.

Hopewell, Lucy J., et al. "Gray Squirrels (*Sciurus Carolinensis*) Show a Feature-Negative Effect Specific to Social Learning." *Animal Cognition*, Vol. 13, No. 2, 2009, pp. 219–227. doi:10.1007/s10071-009-0259-3.

In this study, researchers found that eastern gray squirrels who watched a conspecific fail at obtaining a food reward learned more readily than those who watched a conspecific succeed. My observations indicate that shyer squirrels become more bold as they watch bolder conspecifics obtain food from humans. Since these results seem to contradict each other, I will make note of this in my discussion. This study can also provide ideas for future experiments on social learning among Boston Common squirrels.

Weigl, Peter D., and Elinor V. Hanson. "Observational Learning and the Feeding Behavior of the Red Squirrel *Tamiasciurus Hudsonicus*: The Ontogeny of Optimization." *Ecology*, Vol. 61, No. 2, 1980, pp. 213–218. doi:10.2307/1935176.

In this study, researchers studied the amount of time it took red squirrels to learn how to eat hickory nuts for the first time. One set of squirrels used trial-and-error, while another set was able to observe an experienced conspecific feeding on the nuts. This study found that the squirrels who learned from the model squirrel were more efficient than those who learned via trial-and-error, and that this learning persisted even when the model squirrel was removed. This study supports my claim that social learning occurs among squirrels in the Central Burying Ground.