Age-related response to playback of calls of Sharp-shinned Hawks (*Accipiter striatus*) by American Redstart (*Setophaga ruticilla*) males

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Abstract
We investigated whether the response of American Redstart (*Setophaga ruticilla*) is influenced by age. We recorded song rates before and after playback of a Sharp-shinned Hawk (*Accipiter striatus*) call, and how long after playback redstarts took to sing again. Our results showed no significant differences in response between first year and second year males, but significant reduction in song rate for all redstarts was found immediately post-playback. Future studies should further explore the relationship between response of different aged American Redstarts males and calls of potential predator classes.

1. INTRODUCTION

The American Redstart (*Setophaga ruticilla*) is a common breeding resident in the northern Lower Peninsula of Michigan. A study by Ficken (1962) has described how nesting American Redstarts will change their behavior in response to sighting a predator. The Sharp-shinned Hawk (*Accipiter striatus*) is a small raptor known to prey on many small passerines, including the American Redstart (Blidstein & Meyer, 2000). Some of the redstarts' observed behavioral changes in response to predators include changing its posture, mobbing the predator, crouching in its nest, becoming alert, and/or freezing (Ficken,1962). While the Ficken (1962) study was based on visual stimuli, it is not known if American Redstarts exhibit a behavioral response to auditory stimuli of predators alone. The ability of redstarts to identify predators by both visual and acoustic stimuli may aid in avoiding predation. Because birds generally apply acoustic signals in communication (Kumar, 2003), it is likely that acoustic cues play an important role in response to predators (Martin, et al., 1996). Therefore, we expect that American Redstarts will exhibit many of the same behaviors, described in the 1962 Ficken study, when exposed to a Sharp-shinned Hawk call only. This study assumes that second-year male American Redstarts have had more potential encounters with predators and is therefore expected that older adult males will have a more pronounced response when exposed to a Sharp-shinned Hawk call in comparison with first-year males.

2. METHODS

2.1 Field Methods

Our study took place in the forests surrounding the University of Michigan Biological Station, located in Pellston, Michigan. We chose our data collection areas, Grapevine Trail and Pine Point Trail, because of the high density of redstarts in the area (Kendeigh, 1948). According to Kendeigh, the forest around the trail consists of Sugar Maple (*Acer*

saccharum), American Beech (*Fagus grandifolia*), Red Maple (*Acer rubrum*), and other hardwoods.

We conducted our tests on five different days over a period spanning from 29 May to 7 June 2013.

We created an audio recording to simulate the Sharp-shinned Hawk call. We purchased a 21.0 second Sharp-shinned Hawk call audio clip from The Cornell Lab of Ornithology/Macaulay Library's *Bird Songs of California* album from iTunes. We then loaded this clip into Apple's Garageband application where we cut the audio clip down to 18.03 seconds. We doubled the amount of time the hawk call sounds, for a total playing time of 36.01 seconds. We added four minutes of silence prior to the to hawk call creating an audio file that lasts a total of 4:36.01. This audio file was then downloaded onto an iPhone which served as our playback device. In the field we connected the iPhone to a Labtec CS-150 stereo computer speaker system to amplify the audio file. The entire apparatus was placed on top of a cartographic tripod to elevate the source of sound to better represent the likely location of a hunting Sharp-shinned Hawk.

We used the audio file in our experimental treatments. During the initial 4 minutes of silence, the number of songs sung by the selected redstart would be counted and recorded. Once the Sharp-shinned Hawk call began, the number of songs sung by our target redstart, if any, was counted and recorded. Following the end of the audio file, we recorded the time before a redstart resumed singing during a four minute period, as well as the number of times the redstart sang during this period.

It was difficult to locate and follow birds, so use of visual cues as a response variable could not be accomplished. Identifying the age of the individual male was difficult. First year

males are grey and yellow, resembling the females, while the second year males are black and orange. To rectify this problem, we attempted two different protocols to observe the age of the male.

During our first protocol, we initially located a male redstart by listening for its song, without visually identifying it beforehand. Once located, we would set up the apparatus and begin the audio file. At the end of the audio file, we determined the age using American Redstart playback obtained from the iPhone application iBird Pro 6.1. We allotted 3 minutes for the redstart to respond and come close enough to be aged. This method of identifying and aging the individual proved to be inefficient, since we were unable to get a visual on many of the selected individuals.

We developed a second protocol to better find the selected individual bird. We began locating an American Redstart by listening to its song, then spent no longer than 20 minutes trying to establish a visual without playback. If 20 minutes passed without seeing the redstart, we moved on and located another singing redstart. Once a visual was established, we determined and recorded the age of the individual, then continued with our experimental treatment. This protocol was implemented on 6 and 7 June 2013.

2.2 Statistical Analysis

We computed songs per second before and after hawk calls by dividing number of songs by the time spent singing. We then calculated the difference in song rates before and after the hawk call.

A two sample T-test was done to compare first year males and older males in terms of time taken to resume singing, song rate difference and number of songs during the hawk

call. We also performed a paired T-test containing our entire sample, comparing song rates before and after the hawk call.

3. RESULTS

After data collection, we observed the behavioral response in four first year males and 12 second year males. We also measured the behavioral response in nine males without obtaining a visual identification. Song rates dropped after playing the hawk call (Table 1). First year males on average took longer to continue singing after the hawk call than older males (Table 2).

Significance was determined based on a 95% confidence level. The difference in song rate between first and second year males was insignificant ($p = 0.696$), as was the difference in time each group took to resume singing ($p = 0.198$), and differences in songs during the hawk call ($p = 0.427$). Pooling data from both first and second year males resulted in a significant difference in song rates before and after playback of the hawk calls ($p = 0.000$). These results are summarized in Table 3.

Table 1. Song Rate Before and After Hawk Call (Songs/Minute)

	N	Before Call Rate	After Call Rate
First Year	4	5.38 +/- 2.96	3.54 +/- 4.18
Second Year	12	7.35 +/- 3.62	4.98 +/- 5.00
All	25	6.37 +/- 3.90	4.39 +/- 4.62

Table 2. Time to Resume Singing After Hawk Call

	N	Time Until Singing (sec)
First Year	4	91.00 +/- 142.56
Second Year	12	47.58 +/- 101.00

Table 3. T-Test P-Values

Test	P-Value
First Year vs. Second Year Song Rate Change	0.696
First Year vs. Second Year Time to Resume Singing	0.198
First Year vs. Second Year Songs During Hawk Call	0.427
Full Sample Song Rate Before vs. After	0.000

4. DISCUSSION

The T-tests that compared the differential response between first and second year males were found to be statistically insignificant. We believe that a factor that led to this result was the fact that our first year male sample size was too small and variable. Based on these results, we conclude that there is no significant difference in response to a predatory call between first and second year males. However, the difference in duration of silence following the hawk call suggests a potential difference between first-year and second-year males. This may be due to the fact that a successful Sharp-shinned Hawk captures its prey using the element of surprise. If they reveal themselves by calling, then they are at a disadvantage when trying to catch prey. Experienced second year males may be more familiar with the hunting strategies of Sharp-

shinned Hawks and will therefore be more likely to return to regular activities after a predator call sooner than first year males. A larger sample size would be required to evaluate this further.

Due to a lack of significance between the first and second year males, we ran a paired T-test using the entire data set regardless of age. We ran this test to determine if our experimental protocol was effective at eliciting a behavioral response in redstarts. We found that there was a significant reduction in redstart song frequency after the audio file was played. Decreasing song rate may be adaptive for the redstarts. Redstarts, by becoming silent and singing less, make themselves less conspicuous and reduce a predator's ability to locate them. The individuals may also express more vigilant behavior, looking around for the potential danger, and sing less during these behaviors.

The timeline for the completion of our project was restricted, and this time constraint presented some challenges in our data collection methods. Our original goal was to visually observe a behavioral response in redstarts, but we did not anticipate how time-intensive this would be. Without a visual on the bird, we were unable to identify its age. We implemented various protocols to facilitate the ease of visual identification, which resulted in a lack of standardized data collection methods during the study.

We were unable to obtain visual data for nine birds that received playback. This may be a consequence of being outside the territorial boundary of the subject bird, as redstarts are territorial (Sherry & Holmes, 1989). Future studies should consider mapping out the territory sizes of each individual to be observed within the study site. This would help ascertain if using playback within a territory influences a redstart's response to this playback.

We were also hampered by our inexperience identifying songs of specific individuals. The high density of redstarts made it difficult to ascertain if we were recording the

same individual for the whole experimental treatment because some of the redstarts may not have been stationary. More so, individual redstarts can display variability in their song type, so without a consistent visual it was difficult to ascertain that the correct redstart song was being recorded.

We only measured the behavioral response of redstarts using song alone. Basing measurements solely on song may not accurately depict the behavioral response of redstarts to a predatory auditory stimulus. In the future, it may be helpful to consider redstart calls as well as songs when attempting to measure the behavioral response to auditory stimuli. Additionally, a study by Saunders et al. (2013) measured the response of Piping Plovers to predatory, non-predatory, and parental calls. Including these additional treatments in future studies would likely result in a better measure of redstart behavioral response.

Further changes to the procedure might be implemented to help lower the effect of human disturbances on redstart behavior. In some instances, when searching for a redstart, it would cease singing or move away. Although we tried to minimize human disturbance by using playback near a trail, it is possible the redstarts associated the playback with the observers and not a Sharp-shinned Hawk. We recommend having the call come from an inconspicuous location separate from the observers.

5. CONCLUSIONS

We evaluated whether first and second year American Redstart males respond differently when exposed to a Sharp-shinned Hawk call. We were unable to ascertain if there is any significant difference between these two age classes, but our sample sizes were small. However, our experimental setup proved effective, so future studies may incorporate additional variables, such as redstart or non-predator calls, that may provide a more refined representation of redstart

behavior. Additionally, a better understanding of redstart territorial distribution may help in eliciting a greater response to playback.

Many aspects of migratory species are not well understood, and this study contributes toward understanding mechanisms of how songbirds avoid predators. Although redstarts are numerous, these same findings may be applied to the behaviors of other migratory species.

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