

Response of Central North American Birds to Native Red-Eyed Vireo (*Vireo olivaceus*) and
Non-Native Black-Billed Magpie (*Pica hudsonia*) Alarm Calls: Does Learning Play a Role?

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Madeline Wroblewski

Advisor: Kerri Citterbart Martin

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Abstract

Alarm calling is an important method animals use to avoid predation. The ability different birds have to recognize and respond to other species' alarm calls has been shown to be the result of both call similarity and conditioning, or learning, to associate that call with danger. I examined the response of Central North American birds to both a native Red-Eyed Vireo (*Vireo olivaceus*) alarm call, and a non-native, dissimilar Black-Billed Magpie (*Pica hudsonia*) alarm call, as well as to a native Ovenbird song control (*Seiurus aurocapilla*). Response was measured in terms of time to resume calling and call frequency before and after the treatment. There was no difference in time to resume calling or call frequency between any of the treatments, suggesting that Central North American songbirds do not recognize or respond to either the Red-Eyed Vireo alarm or the non-native Black-Billed Magpie alarm. This response could be because birds have not been exposed to the Red-Eyed Vireo alarm frequently enough to learn to associate it with danger or lack the ability to associate the call with danger. A similar conclusion can be drawn with the Magpie call, as local birds have never been exposed to the call and therefore have never learned to associate it with danger.

Introduction

Predator avoidance is an important part of the daily activities of many prey species, and the more skilled an animal is at avoiding predation, the more likely it is to pass on its genes. One way animals have evolved to avoid predation is through alarm signaling, with natural selection favoring those who produce clear, easy to interpret warning signals and recipients who are adept at interpreting the warning signals (Seyfarth and Cheney 2003). In other words, animals that can effectively and quickly interpret the meaning of warning signals are favored by natural selection.

Different bird species produce a wide array of warning calls. Even though alarm calls may be costly because they can reveal the bird's location to the predator, the call can alert kin, which can take measures to avoid the predator (Seyfarth and Cheney 2003). A warning call can also include information on the severity of the threat. White-Browed Scrubwrens (*Sericornis frontalis*) use more trill notes in their alarm call to indicate a greater predator threat (Leavesley and Magrath 2005). Likewise, Black-Capped Chickadees (*Parus atricapillus*) use more "dee" notes in their mobbing call to indicate greater threat, and a "seet" alarm call to indicate an airborne predator (Templeton et al. 2005). Even though they are not the intended recipient, other species can also eavesdrop on these alarm calls and respond. For example, mammals also have been shown the ability to recognize bird alarm calls (Magrath et. al 2009). Birds can also recognize alarm calls of other birds, with Red-Breasted Nuthatches (*Sitta canadensis*) responding differently to variations in the Black-Capped Chickadee mobbing call (Templeton and Greene 2007).

The ability of birds to respond to heterospecific alarm calls, or calls from other species, has been demonstrated to be a result of both call similarity and learning. Superb Fairy-Wrens (*Malurus cyaneus*) respond to similar sounding calls of other species (Fallow et al. 2011). Apostlebirds (*Struthidea cinerea*), an Australian bird, respond to the mobbing calls of the Carolina Wren (*Thryothorus ludovicianus*), a North American species, despite never having been exposed to the non-native call (Johnson et al. 2003). There is also evidence that learning plays an important role in call recognition. In Sri Lanka, Ashy-Headed Laughingthrush (*Garrulax cinereifrons*), Malabar Trogon (*Harpactes fasciatus*), and Orange Billed-Babbler (*Turoides rufescens*), which forage together in flocks, all respond to the alarm calls of another flock member, the Greater Racket-Tailed Drongo (*Dicrurus paradiseus*) (Goodale and Kotagama

2008). An even more pronounced example of learning is found in some Australian bird species. Superb Fairy Wrens always respond to the dissimilar alarm call of the New Holland Honeyeater (*Phylidonyris novaehollandiae*), which inhabits the same area the wrens, however the wrens respond to the call of the similar sounding White-Browed Scrubwren (*Sericornis frontalis*) only when Scrubwrens inhabited the same area (Magrath et al. 2009). This suggests learning, not only call similarity, is important in bird's ability to be able to recognize alarm calls. Fairy Wrens also only responded to Noisy Miners (*Manorina melanocephala*) in areas where Miners are present, and the Wrens can also distinguish between different types of Miner calls, further suggesting learning (Magrath and Bennett 2012).

Thus, while call similarity may be an important factor in the ability of birds to recognize and respond to different species' alarm calls, exposure and subsequent learning of that call may be equally important. Although research has shown that both call similarity and learning are important factors in heterospecific alarm call recognition, little research has been conducted on this topic in central North American bird species in forested areas. Thus, for North American bird species, the question is whether their alarm calls are instinctual or learned? Specifically, will birds recognize and react similarly to a familiar native alarm call as with an entirely dissimilar non-native alarm call? The specific hypotheses being tested is that North American bird alarm calls are learned, which will be tested by playback experiments of a native bird alarm call and non-native, dissimilar bird alarm call. If the hypothesis is supported, the amount of silence following an alarm call will be greater for supposedly learned native alarm calls than for non-native alarm calls. Also, if the hypothesis is supported, call frequency will decrease after a native alarm call and will decrease less with the non-native alarm call.

Methods

Location and Site Selection

Data was collected at the University of Notre Dame Environmental Research Center (UNDERC) (46°14'N, 89°32'W), a mixed hardwoods forest on the border of northern Wisconsin and the Upper Peninsula of Michigan. Trials were conducted over a 3-week period in June. Six sites, at least 250 meters apart, were selected randomly along two infrequently traveled, unpaved roads. Each site was 50 m away from the road to ensure minimum disturbance. All sites were forested, although forest type ranged from even-age maple stands with little understory, to mixed coniferous stands, to coniferous dominated bog.

Species used and methods of recording

The four treatments used were a recording of a native alarm call, a recording of a non-native, dissimilar alarm call, a recording of a non-threatening song, and silence, or no treatment. The Red-Eyed Vireo (*Vireo olivaceus*) call was used as the native alarm call. Red-Eyed Vireos are a migratory songbird that winters in the Amazon basin. Red-Eyed Vireos are extremely common summer residents in all eastern deciduous forests, including the forest at UNDERC (Cimprich et al. 2000). They produce a catlike 'myaah' call when confronting a predator (Kroodsma 2008). The Black-Billed Magpie's (*Pica hudsonia*) call was used as the non-native alarm call. The Black-Billed Magpie is a non-migratory corvid common in western North America, with a raspy, chatter call and a range that does not extend into UNDERC (Trost 1999), thus local birds have not been exposed to its alarm call. Its alarm call is a set of harsh staccato notes (Stone and Trost 1991). In order to control for speaker usage during playback, the Ovenbird's (*Seiurus aurocapilla*) song was played as a control. The Ovenbird is a non-threatening thrush common in closed canopy eastern forests and common at UNDERC. Audio

recordings of calls and songs were from the Macaulay Library of the Cornell Lab of Ornithology. To control for random variation in calling, a silence control was also used.

Trials were conducted between 5:00 am and 8:00 am on mornings without significant wind or rain. Significant wind was defined as wind speeds no faster than walking speed, and significant rain was no more than a light, intermittent drizzle with not fog, as outlined in the BBird Field Protocol (Martin et al. 1997). Trial order was randomized to eliminate bias, and care was taken to ensure two trials did not occur at the same site on the same morning. Each trial lasted 30 minutes, with a preliminary 10 minute acclimation period where we sat in silence to ensure the birds were not disturbed by our presence. After the preliminary 10 minutes, all bird calls or songs, defined as any bird call that could be recognized as a specific species, the time of the calls, and the species of bird, were recorded for another 10 minutes. Then, the audio was played for 30 seconds using a Sony SRS-A27 speaker at a volume that was approximately the volume of the surrounding bird calls. Calls were then recorded in the same manner for another 10 minutes afterwards to gauge response.

Statistical Tests

Response variables measured were time each species took to resume calling after the treatment, and number of calls each species made 5 minutes before and after the treatment. The time it took each bird species to resume calling after the treatment was averaged and analyzed using a one-way ANOVA. The average amount of time it took commonly occurring species (such as the Red-Eyed Vireo, Ovenbird, and Black-Throated Green Warbler) to resume calling was also recorded and analyzed separately using a one-way ANOVA or Kruskal-Wallis test, when necessary. Data that was not normally distributed and could be made normal was transformed with a log transformation. Change in call frequency was calculated by counting the

number of calls 5 minutes before and 5 minutes after the treatment by each species of bird, then finding the difference between the two. Change in call frequency was averaged for each treatment, and the differences between treatments were analyzed using a one-way ANOVA. Change in call frequency was also analyzed for commonly occurring species, and was calculated and analyzed in the same manner.

Results

22 species of birds were observed in total over the 24 trials (Table 1). Within those species, no difference was observed in their response to the native and non-native alarm, or the Ovenbird song or silence control.

Overall time to resume calling for all bird species was the longest with the silence control with an average of 127.38 (\pm a standard deviation of 53.8) seconds to resume, and was the shortest with the Ovenbird control with an average of 75.1 seconds to resume (\pm 58.62) however there was no significant difference in overall time to resume calling (p -value = 0.486, $F_{3,20} = 0.843$) (Figure 1).

For individual species, no species paused calling significantly after the playback trials. The Red-Eyed Vireo, Ovenbird, and Black-Throated Green Warbler were the species present during enough trials to analyze. There was no difference in the amount of time it took the Red-Eyed Vireo, (p -value = 0.36, $H = 3.1883$, $df=3$) (Figure 2), the Ovenbird, (p -value=0.63, $F_{3,8}=1.818$) (Figure 3), or the Black-Throated Green Warbler (p -value = 0.21, $H=4.5317$, $df=3$) to resume calling after each treatment (Figure 4).

There was also no difference in the overall change in call frequency before and after the native alarm, non-native alarm, or controls (p -value = 0.409, $F_{3,20} = 1.011$) (Figure 5). Although not significant, the species that exhibited the most significant change in call frequency was the

Red-Eyed Vireo, which on average called 19.5 (± 21.70) fewer times after the native alarm call and increased an average of 5 calls after the Ovenbird control (p-value=0.12, H=5.8697, df=3) (Figure 6a). The Ovenbird did not show any significant reaction in terms of call frequency (p-value=0.99, H= 0.1188, df=3) (Figure 6b).

Discussion

There was no difference in overall bird response to the native Red-Eyed Vireo alarm call and the non-native Black-Billed Magpie alarm call, both in terms of average time to resume calling and average change in call frequency (Figures 1 and 5), not supporting the hypothesis that birds overall would respond more intensely to native alarm calls than non-native alarm calls.

The lack of overall response to both alarm calls was surprising, as birds did not even respond to the native Red-Eyed Vireo alarm call, which they should have had the opportunity to learn. Vireos did exhibit a trend in decreased call frequency after their own alarm call, but the trend was not significant. This suggests that Vireos may have recognized their own alarm call and responded by decreasing call frequency, but more replication needs to be done to confirm this trend.

Overall, there was a lack of response to the Magpie alarm call, suggesting the non-native call did not affect birds, which was somewhat consistent with the hypothesis that the call would have minimal impact because it had not been learned. Birds have been shown not to recognize unknown alarm calls, especially alarm calls that differ substantially from their own (Magrath et al. 2009), as was in the case of the Magpie alarm. In addition, lack of response to the Magpie call shows that birds were not responding to a novel sound. Novel sounds or birds can elicit a response. Willow tits (*Parus montanus*) have been shown to respond by alarm calling to novel or

unthreatening sounds, including airplanes or large but harmless birds (Haftorn 2000). Thus, the lack of response suggests the Magpie call was not viewed as indicative of a threat.

Despite the suggestion of a trend, the ultimate lack of response to the Vireo alarm call was surprising. Central North American birds have been demonstrated to understand the calls of some heterospecifics. The Black-Capped Chickadee (*Parus atricapillus*) mobbing call has been shown to attract up to 24 other species of birds (Hurd 1996). Red-Breasted Nuthatches (*Sitta canadensis*), another species present at the study site, also respond to the Chickadee mobbing call and have even been demonstrated to understand differences in mobbing call type (Templeton and Greene 2007), thus local birds are able to understand some of their neighbors calls.

There is a possibility birds responded by a variable that was not measured. As birds were only characterized acoustically, some less noticeable behaviors may have gone unrecorded. Some anti-predatory behaviors that do not involve calls are momentary increased vigilance, decreased foraging, or tail flicking, a behavior that alerts predators that the bird is alert and ready to escape attack, and these behaviors could have been missed (Woodland et al. 1980; Alvarez 1993). Mild responses to heterospecific alarm calls that include these behaviors have been demonstrated in Zenaida Doves (*Zenaida aurita*) and Carib Grackles (*Quiscalus lugubris*). Doves flee for cover in response to a predator model, but respond to Grackle alarm call only by suppressed foraging, increased alertness, and tail flicks (Griffin et al. 2005). However, predator detection is often accompanied by halted singing, which decreases the conspicuousness of the bird (Møller 1992; Gil and Gahr 2002), and decreased singing was not observed. Ultimately, it is possible birds may have recognized the Vireo call as indicative of danger and did not respond because additional cues indicating danger, such as the presence of a predator, were absent.

Another possibility explaining the lack of response is local birds simply have not learned the Red-Eyed Vireo alarm call. Exposure to an alarm call and conditioning seem to be necessary for many animals to associate a sound with danger. For example, only adult Bonnet Macaques (*Macaca radiata*) that have had time to learn the alarm calls of other primates respond to the calls of heterospecifics. In areas where these heterospecifics are absent Macaques do not respond to their alarm calls as they have not had enough exposure to learn (Ramakrishnan and Coss 2000). Even more dramatic, Golden-Mantled Ground Squirrels (*Callospermophilus lateralis*) can be conditioned to respond with antipredator behavior to a neutral, unnatural tone by associating that tone with a predator model (Shriner 2001). Having the opportunity to learn heterospecific calls is important in birds as well, as oftentimes birds only respond to the alarms of heterospecifics if these heterospecifics live in the same area (Magrath et al. 2009). Thus, there are two possibilities why the studied birds did not respond to the Vireo alarm, it may be because they lack the capability to learn the call, or they have not been exposed to the Red-Eyed Vireo alarm call frequently enough to learn its association with danger. With minimal research on Red-Eyed Vireo alarm calls and escape tactics (Lima 1993), more investigation should be done to determine if and how Central North American birds respond to Vireo alarm calls.

Predator avoidance remains a vital part of any animal's life and reproductive success. Understanding how bird species detect and avoid potential predators is important not only to the survival of individuals or species, but the health of whole ecosystems. With North American bird species composition changing and species rapidly moving northward with climate change, up to 2.35 km a year (Hitch and Leberg 2007), it is imperative we understand how birds determine what is dangerous, and if they use information from heterospecifics to do so. While this study determined birds do not respond to the Red-Eyed Vireo, they also inherently do not understand

the alarm calls of non-native birds, thus shifts in species composition may not negatively effect how birds detect potential predators. However, more research must be done on North American birds and their reliance on heterospecific calls for predator avoidance.

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Tables

Bird	Number of Trials Observed
Red-Eyed Vireo	23
Ovenbird	21
Nashville Warbler	18
Blue Jay	17
Hermit Thrush	15
Rose-Breasted Grosbeak	14
Black-Throated Green Warbler	12
American Robin	10
White-Throated Sparrow	10
Black-Capped Chickadee	9
Rose-Breasted Nuthatch	9
Black and White Warbler	8
Least Flycatcher	8
Woodpecker	9

Northern Parula	5
Wood Thrush	4
American Crow	3
Red-Winged Blackbird	3
Common Loon	1
Common Yellowthroat	1
Eastern Wood-Pewee	1
Song Sparrow	1
Veery	1

Table 1. Number of treatments during which each bird species was observed

Figures

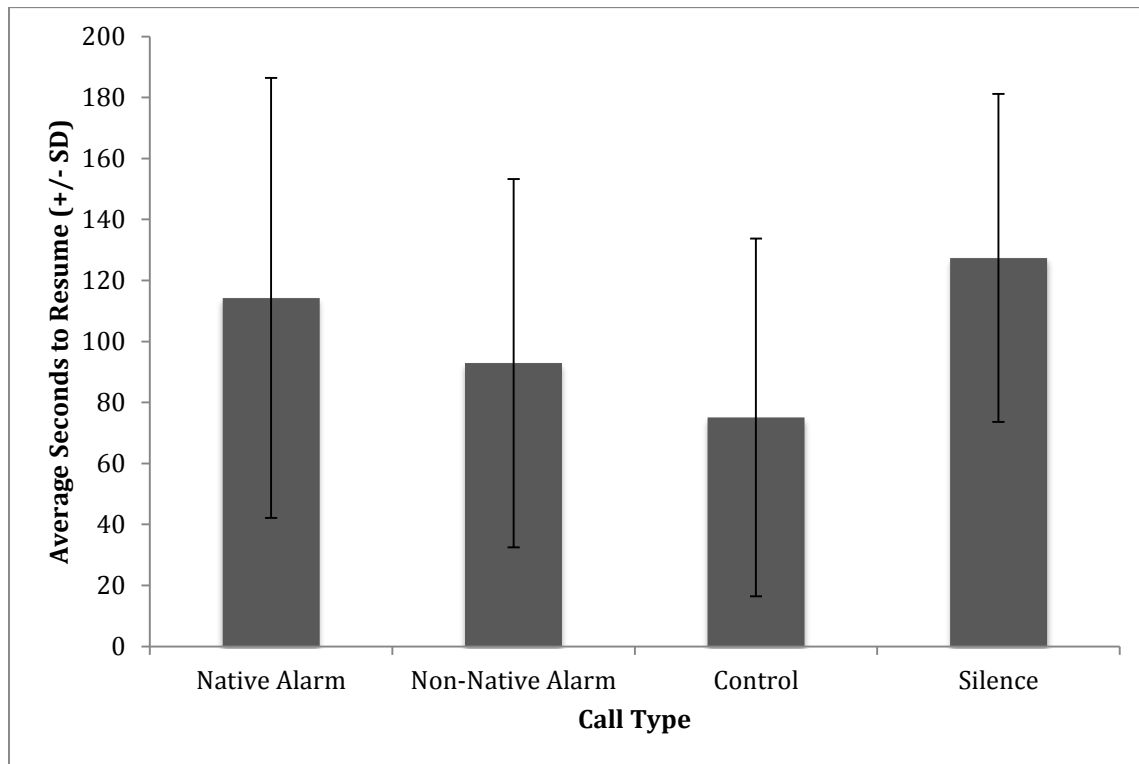


Figure 1: Average time for each species of bird to resume calling after the playback of a native Red-Eyed Vireo alarm, non-native Black-Billed Magpie alarm, Ovenbird song control, or silence, with standard deviation. The variation in time to respond was not significant (p-value = 0.466, $F_{3,20} = 0.843$).

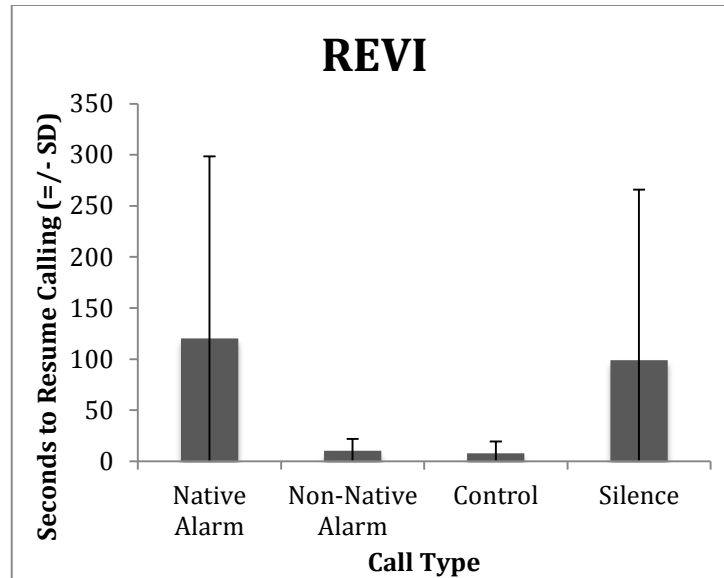


Figure 2. Average time to resume calling for the Red-Eyed Vireo (REVI). Time to resume calling did not vary between treatments (REVI p-value=0.36, H= 3.1883).

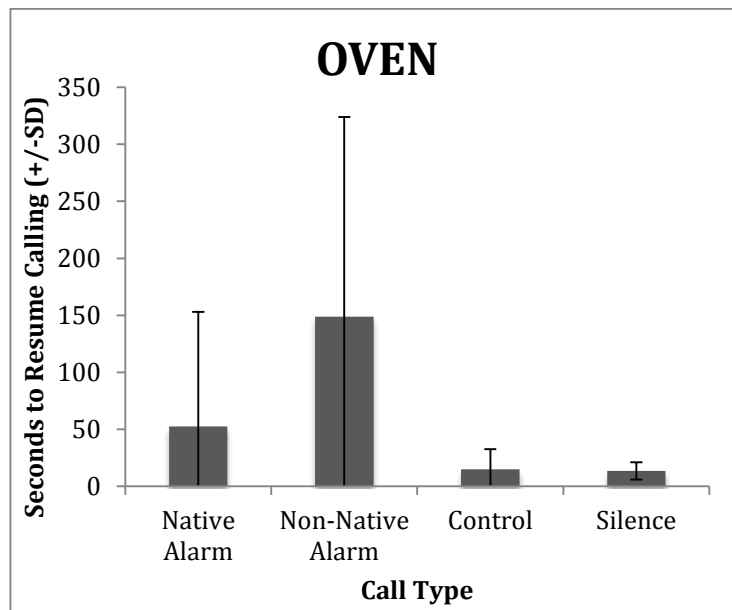


Figure 3. Average time to resume calling for the Ovenbird (OVEN) after each treatment. Time to resume calling did not vary between treatments (OVEN p-value = 0.63, $F_{3,8}=1.818$).

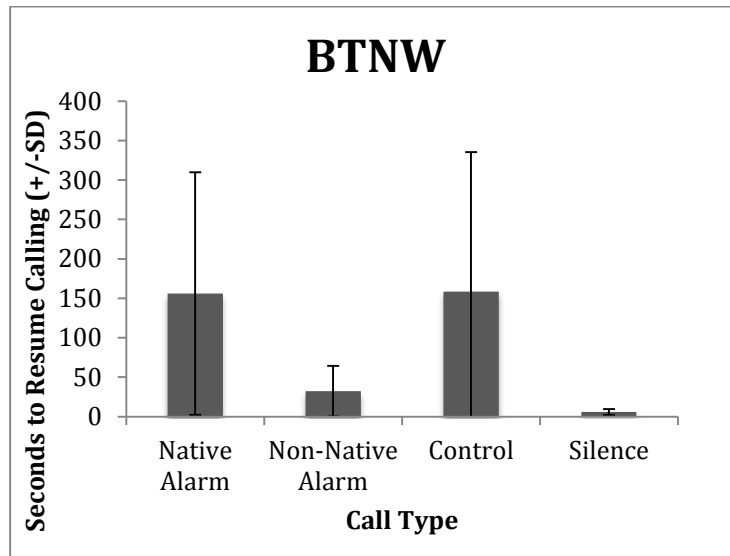


Figure 4: Average time to resume calling after each treatment for the Black-Throated Green Warbler (BTGW). Time to resume calling did not vary between treatments (BTGW p-value = 0.21, H=4.5317).

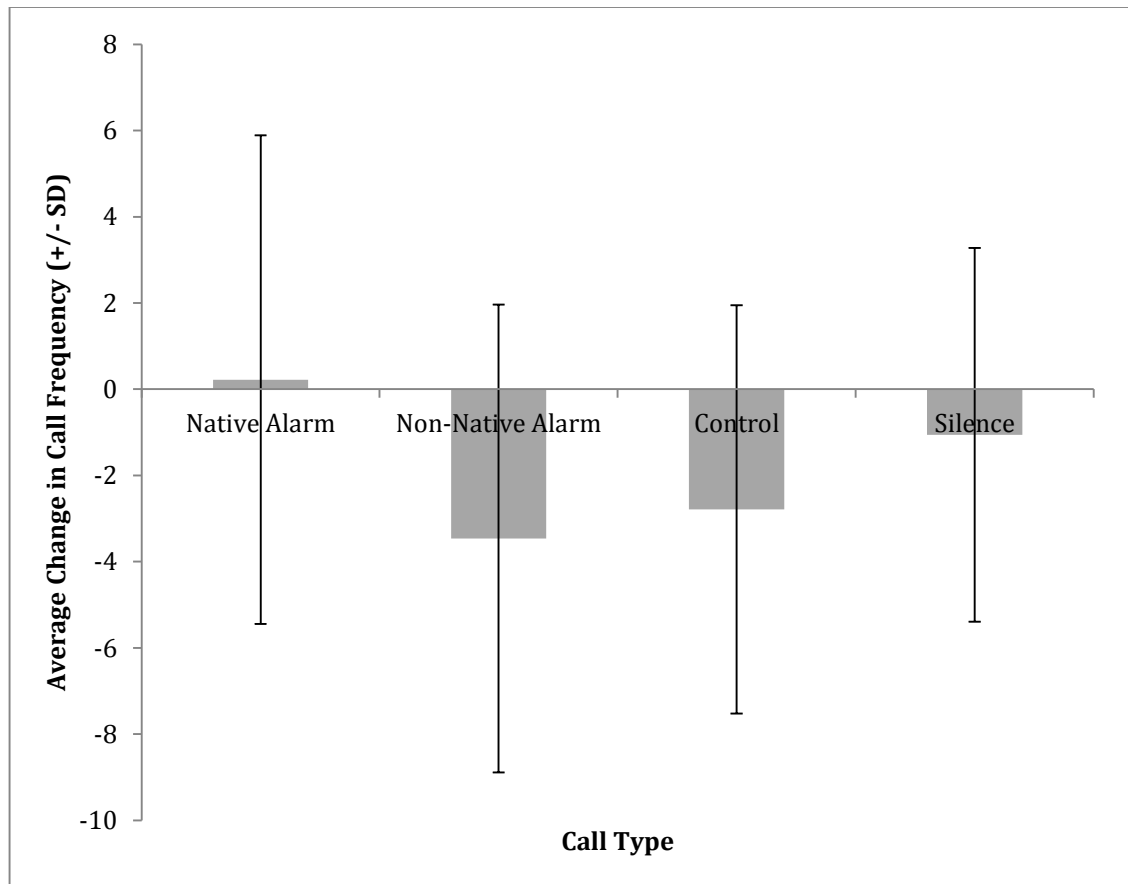


Figure 5: Average difference in number of calls by each bird species 5 minutes before and 5 minutes after the playback of a native Red-Eyed Vireo alarm, non-native Black-Billed Magpie alarm, Ovenbird song control, or silence, with standard deviation. The variation in change in call frequency was not significant (p-value = 0.409, $F_{3,20} = 1.011$).

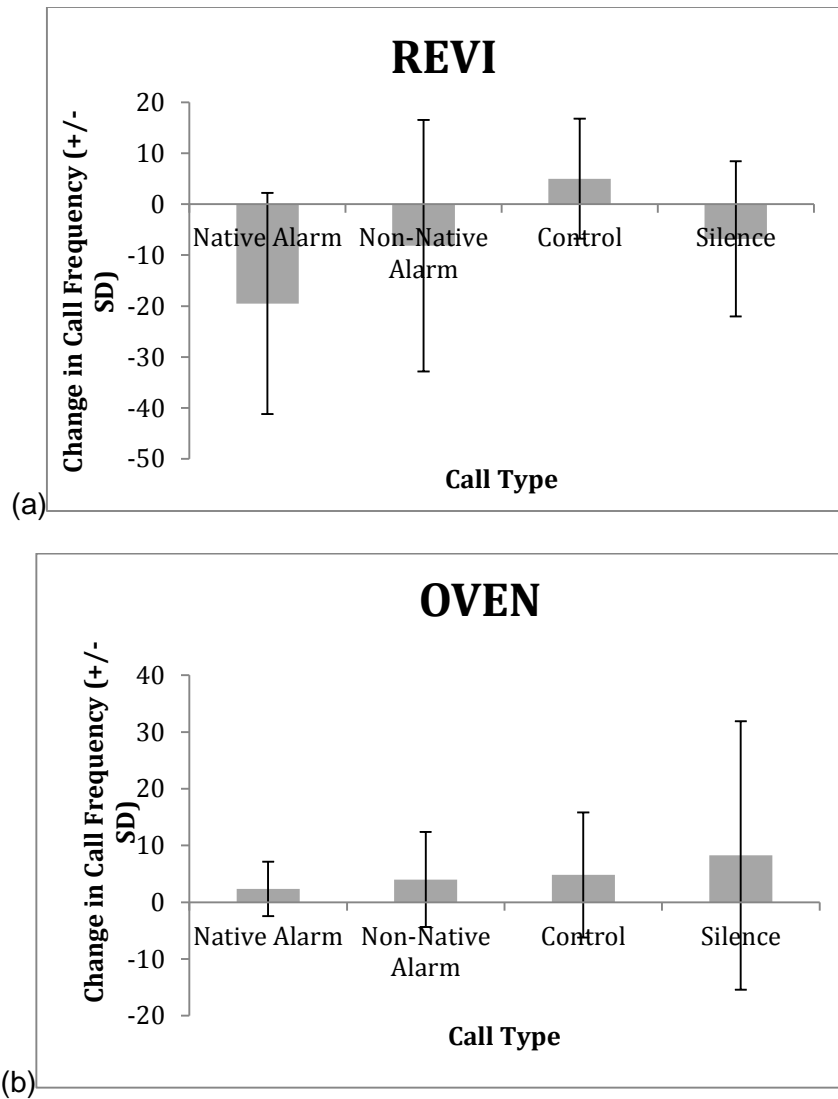


Figure 6: Average difference in the number of Red-Eyed Vireo Calls (REVI) (a) and Ovenbird (OVEN) (b) calls 5 minutes before and 5 minutes after treatment. The variation in Vireo call frequency was not significant (p -value=0.12, H =5.8697), however Vireos did decrease an average of 19.5 calls (± 21.7) after playback of the native alarm call. The variation in Ovenbird call frequency was not significant (p -value=0.99, H =0.118).

