Behavioral response of mountain white-crowned sparrows towards an interspecific competitor

Rachel Siller
Mentor: Ross Conover

Full Time Independent Research
Summer 2014

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Rachel S. Siller[1], Ross R. Conover[1,2], and Daniel T. Blumstein[1,3]

[1]Rocky Mountain Biological Laboratory, Gothic, CO
[2]Glenville State College, Glenville, WV
[3]University of California, Los Angeles, CA

ABSTRACT

This study examined interspecific competition between mountain white-crowned sparrows (*Zonotrichia leucophrys oriantha)* and Lincoln's sparrows (*Melospiza lincolnii)* using a playback experiment. Mountain white-crowned sparrow males were presented with three different song playback factors: 1) a negative control of a novel song (Tropical Kingbird, *Tyrannus melancholicus*), 2) a positive control of a conspecific song, and 3) a treatment of a heterospecific song (Lincoln's sparrow). Behavior was recorded before and after the playback and analyzed by comparing the difference from baseline in nine behavioral expressions between the three stimuli. A response was seen for attentive behaviors after both the conspecific and heterospecific playbacks (P=0.36 and 0.25 respectively) with no change in behavior to the control. There was a decrease in relaxed behaviors after the conspecific playbacks. Food supplementation was not found to affect the bird's response. These results show that the mountain white-crowned sparrows responds to the intrusion of not only a conspecific male on their territory but also pay attention to and alter their behavior towards a heterospecific competitor.

INTRODUCTION

Interspecific competitive interactions influence avian fitness by affecting the territorial distribution of species and access to resources. Typically when two species compete the larger species will react aggressively towards the other's song and can prevent their access to that territory (Robinson and Terborgh 1995). For some species this competition is seasonal with resources acting as a limiting factor (DuBowy 1988). When resources are limited or in high demand during breeding season, species with high niche overlap may specialize their food sources to reduce this overlap (DuBowy 1988, Beaulieu and Sockman 2012).

The effect of resource availability on avian competition has been examined in other species. Male hummingbirds will chase out a higher percentage of intruders after their territories were nectar supplemented (Dearborn 1998). This increase in aggression with improvement of territory quality is not consistent across avian species. More aggressive eastern bluebirds will hold higher quality territories, but if territory quality is manipulated after territories have been set, the individual males do not change the level of their aggression (Duckworth 2006).

Two known competitors in high alpine valleys include mountain white-crowned sparrows (*Zonotrichia leucophrys oriantha*: hereafter, MWCS) and Lincoln's sparrows (*Melospiza lincolnii)*. MWCS are a subspecies of white-crowned sparrows that breed in high elevation meadows. For MWCS breeding habitat, they require patches of bare ground and grass mixed with dense shrubs and running water (Chilton et al. 1995). During the breeding season, they supplement their seed based diet with arthropods that they forage for on the ground and vegetation or catch in the air (Chilton et al. 1995). Lincoln's sparrows (hereafter LISP) are a smaller sparrow species often inhabiting the same meadow areas (R. Siller, personal observation). This species also prefers dense willow dominated habitat to breed in boggy or riparian areas (Ammon. 1995). Like the MWCS they supplement their seed diet during the breeding season with arthropods that they glean from the ground and low vegetation (Ammon. 1995). During the breeding season, Lincoln's sparrows that inhabit the same meadows as white-crowned sparrows have proportionately reduced arthropods in their diet, potentially indicating interspecific dominance regarding access to food sources (Beaulieu and Sockman 2012).

This study aims to measure behavioral response of MWCS to competitors and what factors influence their response towards an interspecific competitor (i.e. LISP). Due to the high niche overlap of MWCS and LISP we hypothesize that MWCS will respond to a LISP intruder. We then hypothesized that males will behave differently depending on the quality of territory that they hold. Males holding higher quality territories were expected to react more aggressively.

METHODS

Study site

This study was conducted in the upper East River Valley north of the Rocky Mountain Biological Laboratory in Gunnison County, CO (38.9563802° N, -107.0106015° W) during the summers (01June to 01 August) of 2013 and 2014. We monitored four distinct study plots of which plant communities were predominantly willow *(Salix* spp.), *Veratrum* spp, and Cinquefoil (*Potentilla* spp.) and a variety of wildflower species (Figure 1). The study plots ranged from 2913 to 3010 m in elevation.

To study the effects of territory quality, half of the study plots were food supplemented. Food supplemented plots received seed every day regardless of whether traps were opened that day while non-supplemented plots received seed only when the traps were opened. Supplementation was found to have no effect on the bird's behavior ($P>0.222$). Lack of effect of seed quantity is likely due to the importance of arthropods in MWCS diet during the breeding season.

Bird banding

MWCS were trapped using Potter traps, which are wire ground traps, baited with a seed mixture composed primarily of white proso millet (*Panicum miliaceum*). Seed was baked before use to prevent the introduction of non-native plants. Traps were slightly concealed near the edges of willows and opened between 0600 and 1200 hours every day during June and July 2013. The trap lines were checked every hour for captured birds. During 2013 traps were opened between 6 June to 23 July and during 2014 they were opened between 7 June and 31 July. Target birds not captured in Potter traps were caught with mist nests set up on their territory and attracted with playback of a MWCS song.

Each MWCS was banded with a uniquely numbered, butt-end, United States Geological Survey metal leg band (size 1B). Males received the metal band on the right leg and females on the left. The sex of the bird was determined by the size of the cloacal protuberance, females <4mm and males ≥4mm and/or the presence of a brood patch. Each bird was also given a unique combination of colored leg bands to facilitate individual identification without capture.

Upon the first capture of the season, we measured tarsus, culmen length, total crown width (between the eyes) and median crown stripe width using calipers to the

nearest 0.1mm. Wing chord and rectrices length were measured using a ruler to the nearest 1.0mm. Total crown and stripe widths were measured to estimate the proportional width of stripe to crown (Laubach et al. 2013). With each capture, the cloacal protuberance, brood patch stage, abdominal and furcular fat deposits and weight were measured. Mass was determined using a Pesola© spring scale to the nearest 0.5g.

Playbacks

Playback experiments were conducted between 25 June and 18 July in both years. Territory holding male MWCS's were detected by their singing behavior. A total of 32 birds were used in the experiment, 17 in 2013 and 15 in 2014. All behavioral responses to playbacks were recorded by one observer (R. Siller) to minimize observer bias. Pilot observations were conducted before the start of the actual experiment to standardize behavioral interpretations. The observer directed the playback towards an actively singing male from an estimated distance of 15 meters. Playbacks were transmitted by a Sony™ Model SRS-77 G speaker with a precalibrated (at 1m distance) amplitude of 85-87 decibels. Each male was presented with three different playback treatments over three separate days. The playbacks were presented on separate days so that response to one playback would not influence the bird's response to the next playback. Playback treatments included 1) a negative control using a tropical kingbird (*Tyrannus melancholicus*) song, 2) an interspecific competitor's song (LISP), and 3) a positive control of a conspecific song. Six different songs of each treatment were used for the experiment. The tropical kingbird song represented a negative control because it is a novel sound that is unfamiliar to this MWCS population. This song was obtained from a commercially produced CD (Oberle 2008). MWCS and LISP songs were recorded from six different territorial males in the East River Valley using a Sennheise MZW 816 microphone and a Marantz solid-state PMD660 recorder. The song recordings were imported and cut using Raven 1.0© and standardized at 95% using Sound Studio.

Song types and playback order were presented to the birds using a systematically randomized design to determine which playback was presented on which day. There were three components to the playbacks, 1) thirty seconds of silence to allow for observation of baseline behavior, 2) a short one or two second song, and 3) one minute of silence for post-playback behavioral observation. The behavioral responses of the resident male

were observed and scored to quantify behavioral expression using an ethogram of 9 distinctive behavioral expressions: chink calls, forage, flight, hop, out of sight, preen, stand and look, walk, and vocalize (Slaughter et al. 2013). The chink call is known to be an important aggressive response (Laubach et al. 2013). These behaviors were recorded using a tape recorder and later transcribed and scored using JWatcher 1.0 (Blumstein and Daniel 2007).

Statistical analyses

Statistical analyses were run using IBM SPSS Statistics version 21. Analysis was done on the difference in proportion of time spent on each behavior for the thirty seconds following the playback to the thirty seconds of baseline behavior. General linear models with repeated measures to account for using the same bird multiple times were used to analyze four suites of behavioral expressions. The suites of behavioral expressions analyzed were stand and look, vocalization, relaxed, and locomotion. Relaxed behaviors included preening, foraging and walking. Locomotion included flights, hops, and walking. General linear models were also used to compare environmental conditions (temperature, wind, distance from speaker, year, day of year) between the different playback treatments. Graphs of 95% confidence intervals were made using Statview. Effect size was also calculated for analyzed behaviors using Cohen's d-scores.

RESULTS

We analyzed 32 total birds over the 2013 and 2014 field seasons. Five of those lacked fitness covariate data. Stand and look behavior was observed in all 96 playback experiments, vocalization were recorded in 95.8% of the experiments. Locomotion and relaxed behavior were more rare, occurring in 40.6% and 52.1% of the experiments respectively. Chipping behavior was only recorded in three experiments, once after a heterospecific song and twice after a conspecific song. Due to the limited sample of chipping, this behavior was excluded from further analysis.

The birds responded to both the conspecific and heterospecific playbacks by increasing their stand and look behavior but they did not react to the negative control (Figure 2). For stand and look behavior, the conspecific and heterospecific significantly

differed from the control (P=0.036 and P=0.025 respectively) but did not differ from each other (P=0.968).

Relaxed behavior decreased after both the conspecific playback and heterospecific, but was not affected by the control (Figure 2). This reaction can be seen in the 95% confidence intervals as confidence intervals for conspecific (lower bound=-0.096, upper bound=-0.032) and heterospecific (lower bound=-0.122, upper bound=-0.004) playbacks do not include zero. The greater variation in reaction towards the heterospecific playback made it statistically impossible to differentiate it from the control (P=0.143) and from the conspecific (P=0.968).

There was no reaction to any of the stimuli in locomotion behavior (Figure 2). None of the stimuli were significantly different from each other for this behavioral suite (control vs conspecific P=0.92, control vs heterospecific P=0.659, conspecific vs heterospecific P=0.741).

There was no reaction in vocalization behavior in response to either the control or conspecific playback, but after the heterospecific playback the birds responded by decreasing their song production (Figure 2). This response was not statistically significant and could not be distinguished between any of the stimuli (control vs conspecific P=0.803, control vs heterospecific P=0.199, conspecific vs heterospecific P=0.485).

Supplementation was not found to have a significant affect on the behavioral response of the birds for any of the behavioral suites tested (stand and look by supplementation P=0.869, relaxed by supplementation P=0.225, locomotion by supplementation P=0.222, vocalization by supplementation P=0.788). Other environmental factors tested also did not differ between the two treatments so could not act as confounding variables and so were excluded from the models (wind P=0.814, distance from bird P=0.871, time of day P=0.688, day of year P=0.992, temperature P=0.063).

There was no significant effect from the track used in the playback for either the control or the conspecific playbacks for any of the behaviors ($P>0$.184, P>0.232). There was no significant effect from track for heterospecific playback for stand and look, relaxed, or vocalization (P>0.527). There was an effect of track for heterospecific playbacks in vocalization (P=0.015); track 2 differed from track 6 (P=0.037), track 3

differed from track 4 (P=0.005) and track 3 differed from track 6 (P=0.001). No other differences between the other combinations of heterospecific tracks were found.

DISCUSSION

The first hypothesis was that interspecific competition could be detected from males' responses to an interspecific competitors song. This was supported by the data and suggests that MWCS pay attention not only to an intrusion by another bird of their own species but by a heterospecific competitor as well. This response is most strongly demonstrated in an increase in their attentive behavior (a.k.a. stand and look). It was also apparent in a decrease in relaxed behavior towards both the conspecific and heterospecific playback. While the change in relaxed behavior was similar for both types of competition, the decrease in relaxed behavior was most clearly distinguishable in response to the conspecific song. This suggests that while they react to both types of intruders, an intrusion by a conspecific is more stressful to the MWCS.

There was no or little response to any stimuli in locomotion and vocalization behaviors. These behaviors would be the most energetically demanding on the bird and the lack of response may be due to this limitation. The response may be minimal and hard to distinguish at this level. Further stimulation of the MWCS males with a more prolonged simulated intrusion may help to clarify the trend for decreased vocalization in the heterospecific playback or understand at what point the MWCS is willing to an intruder with these more aggressive and energetically demanding behaviors.

It does not appear that interspecific competition can be distinguished from intraspecific competition by these methods as the means for change in behavior after both heterospecific and conspecific playbacks overlapped in all behavioral expressions (Figure 1). This shows that territorial males will respond to the intrusion of competitor species as well as intruders of their own species and this behavioral reaction suggests that interference competition may be responsible for the separation of foraging tropic levels that occur during the breeding season (Beaulieu and Sockman 2012).

Our second hypothesis was that males holding higher quality territory would have a greater response to the playbacks. This was not supported by the experiment. None of the fitness covariates measured had a significant effect on the MWCS response to any of

the stimuli. This seems to contradict the results from Laubach et al. (2013); crown-white proportion is important for intraspecific actions but our results suggest that they do not play a role in interspecific encounters. The difference in these results may be due to the difference in methods. Future studies could use models or lengthened playback to simulate a more natural interaction with an intruder, which may result in increased responses (Dablesteen et al. 1990, Osiejuk et al. 2007).

Supplementation was also found to be insignificant. This shows that food supplementation and assumed higher quality territory did not affect how the MWCS responded to the stimuli. This may show that the behavior of each individual is consistent regardless of change in territory quality as the food supplementation did not begin until after the MWCS had already arrived in the valley for the summer similar to what was found in eastern bluebirds (Duckworth 2006). It is possible that this result may also be due to the importance of arthropods in the MWCS diet during the breeding season (Chilton et al. 1995). The grain added might not provide a significant increase in the food resources utilized by the birds during this period in their life cycle.

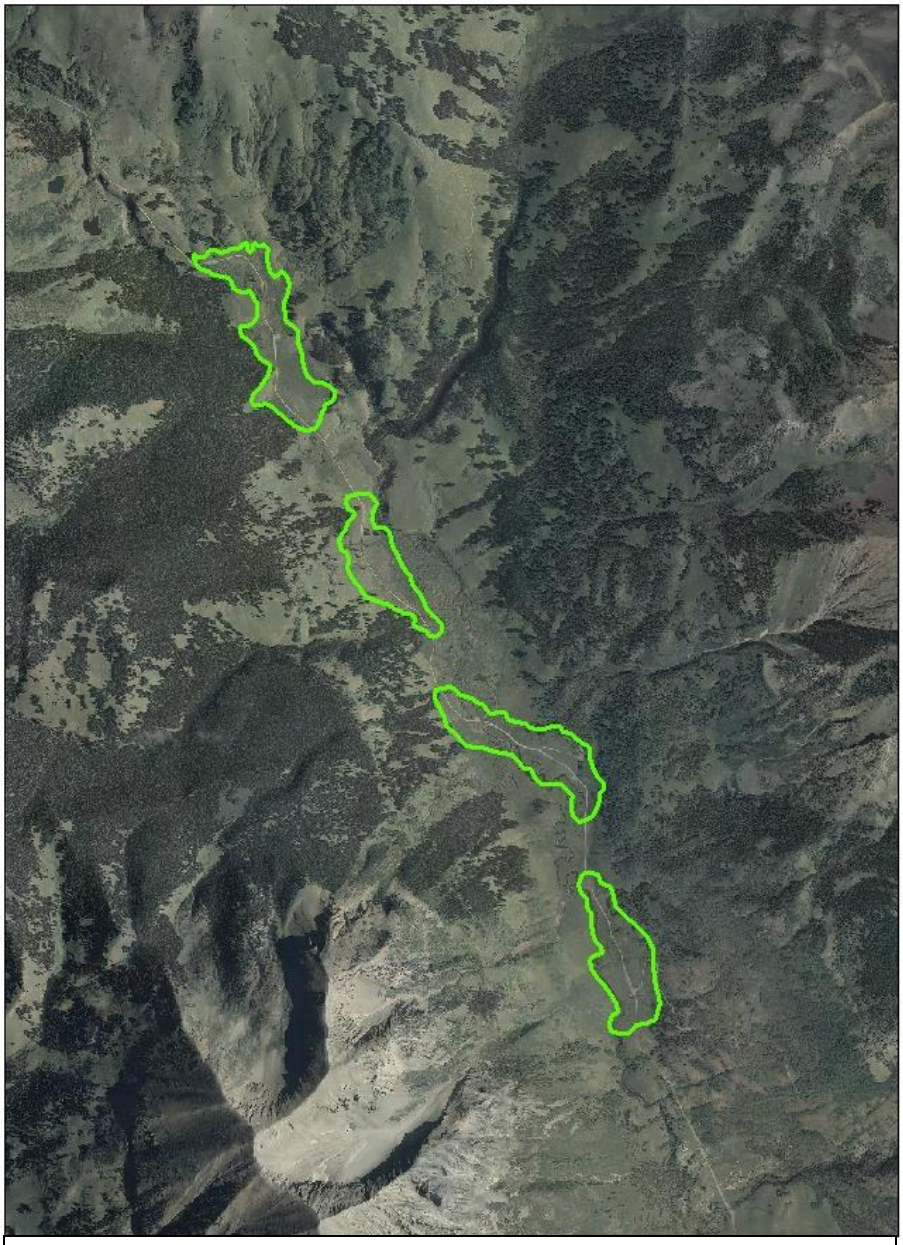

Figure 1: Map of the four study plots in the East River Valley. Elevation ranged between 2913 to 3010 m.

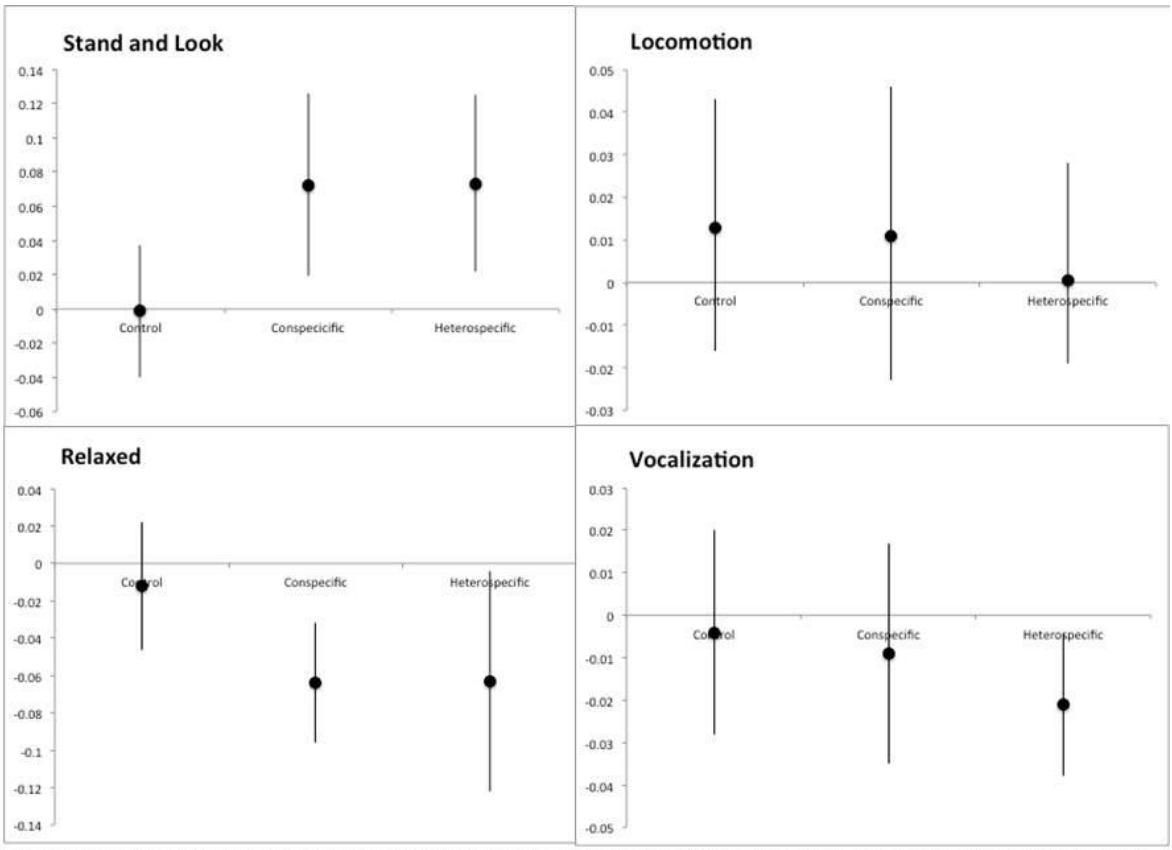

Figure 2: Arcsin transformed mean difference from baseline in proportion time (±95% CI). Response to stimuli can be seen in after the conspecific and heterospecific playbacks in stand and look behavior and relaxed behaviors as the intervals do not include zero. A response is also apparent after heterospecific playback in vocalization. All other intervals include zero and so show no response to the stimulus.

Acknowledgements

We would like to thank Mikayla Thistle, Harriet Morgan, and Catherine Welke for field assistance and the Rocky Mountain Biological Laboratory for logistical assistance. Research was conducted under USGS federal bird banding permit #23680 and state of Colorado scientific collection license #13TRb2060. All procedures were approved by the Rocky Mountain Biological Laboratory Animal Care and Use Committee.

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