Group 4 Chickadees Project Outline

Title slide:

Background info:

Helpful background info for audience.

Black capped chickadees are small, non-migratory birds found in the northern United States and Canada. They live in both rural and urban environments, and eat mostly insects and seeds. These birds have a high level of neuro-flexibility, for example:

Every autumn Black-capped Chickadees allow brain neurons containing old information to die, replacing them with new neurons so they can adapt to changes in their social flocks and environment even with their tiny brains. ([https://www.allaboutbirds.org/guide/Black-capped\_Chickadee/overview#](https://www.allaboutbirds.org/guide/Black-capped_Chickadee/overview))

Need context for the study and why it was done.

How innovative are chickadees at solving problems? What are the traits of birds who are the best at solving problems? Animal innovation, which would be the use of novel behaviors to meet challenges, play a role in the evolution of animals. The study birds were presented with a simple puzzle for a food reward.

Sample image of lever and paper shredding tests:

A picture containing floor

Description automatically generated

What was the goal of the study?

This study compares the problem-solving innovation rate by the effect of dominance rank, exploratory personality, and the urbanization of the capture sites, which were located in and around Ottowa, Canada.

Goals of Study:

What was the overall time to solving the problems (lever pulling, paper ripping, and persistence & repeatability) for chickadees? What covariates/characteristics were most closely predictive of whether a chickadee figured out the problems?

Data and Methodology:

* How was the data collected?
* What data was collected?
  + response variables
  + covariates and/or factors
* What were the experimental/observational units? 2 experiments measured in seconds
* What was the sample size? 70 birds total

some studies have found no relationship between novelty responses and problem-solving performance, suggesting that these traits can vary independently in some species

Some NA values in dominance score, so sample size lower. We’re missing a few.

We investigated the effects of dominance rank, exploratory tendency, and urbanisation on the individual problem-solving performance of wild-caught black-capped chickadees (Poecile atricapillus) using two distinct foraging tasks. Problem-solving performance serves as a proxy for innovation, with birds required to complete each step of the innovation process to successfully solve a task (i.e. discovering the problem, contacting the task, and interacting with it to reach a solution). The black-capped chickadee belongs to Paridae, an avian family showing a high number of innovations in the wild [[27](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref027)], and is a widespread North American species occurring in rural and urban habitats. In the non-breeding season, members of this species form stable groups with linear dominance hierarchies.

Upon capture, each individual was fitted with metal and coloured leg bands as well as a unique passive integrated transponder (PIT) tag. Birds were categorized as juvenile (bird born in the previous spring) or adult (more than one year old) by inspecting the shape and wear of their tail feathers [[37](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref037)]. After capture, birds were transported and housed in individual cages, allowing only auditory contact between individuals, in the animal care facility of the University of Ottawa. Outside of testing periods, birds were given ad libitum access to food (sunflower seeds) and water, and mealworms at the end of each day. On the last day in captivity, before being released back at their site of origin, blood samples were taken from the brachial vein of each subject for molecular sexing [[36](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref036),[38](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref038)]. Subjects were released at their site of capture after a total of 5 days at the university.

From October to December 2016, a maximum of 12 birds were captured weekly using mist nets from one of seven sites in and around Ottawa, Ontario ([Fig 1](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone-0217464-g001)). The degree of urbanisation at each site was assessed using remote sensing data [[32](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref032)–[35](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref035)] by quantifying the number of pixels classified as different land cover types (building, tarmac, forest, and bare earth) within a 1 km radius of capture sites. These variables were used in a principal components analysis (PCA) to generate a unique urban score that explained the degree of urbanisation at each site (81.82% of variance explained by PC1, [[36](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref036)]). Urban score was replaced with a binary habitat variable (urban/rural) in our final models to assess the robustness of our conclusions. Urban sites were urban parks surrounded by houses and located no more than 10 km from downtown Ottawa, and rural sites were forested areas in a rural landscape at least 25 km from downtown.

In captivity, each bird underwent two problem-solving trials for each of two extractive foraging tasks that required the use of different motor actions to solve. The lever-pulling task consisted of a small Perspex tube in which two wax worms were held on top of a platform supported by a lever ([Fig 2A](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone-0217464-g002); similar to [[19](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref019)]). To reduce accidental solutions the lever was placed in the task at a slight downward angle. Birds were required to pull the lever completely out of the tube, causing the food reward to fall out. The paper-ripping task consisted of the bottom half of a Petri dish, containing seeds and mealworms, wrapped with white paper towel ([Fig 2B](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone-0217464-g002); similar to [[39](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref039)]). This task was solved when a bird ripped a hole through the paper that was big enough to extract a seed or worm. Birds were expected to be motivated to search for food in the opaque paper-ripping task, as the mealworms they received at the end of each day in captivity were presented in Petri dishes placed in the same location as the task. However, food deprivation periods were used prior to paper-ripping trials to increase the likelihood of birds interacting with this task (see below).

The ‘extended’ version of the analysis includes time-dependent covariates (see below), which are variables whose value for a particular subject changes over the course of the study [[51](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref051)]

We coded individuals that failed to solve during the experiment as censored observations, since we do not know their true latency to solve (e.g. [[23](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217464#pone.0217464.ref023)]). For instances in which birds solved with wings, or worms escaped from the lever-pulling device (11/70 birds), we also assigned censored latencies up to the time of the incident. Individuals that had retrieved cached seeds during the trials (10/70 birds, all during paper-ripping) were excluded from paper-ripping analyses.

We built a separate extended cox proportional hazards model for each task, setting the latency to solve as the response variable and capture site as a random intercept.

When analysing the characteristics associated with persistence, we used each bird’s total number of contacts (until the task was solved or the observation became censored) as our response variable

covariates and/or factors

we controlled for the number of contacts made with the task throughout the two trials (persistence) as a time-dependent covariate. Our measure of persistence fits the definition of a time-dependent covariate, because the number of contacts made with a task increased as the trials progressed. When analysing a time-dependent covariate, the study period is divided into time intervals and the time-dependent covariate has a different value in each interval.

Results/Analysis:

Conclusions:

In conclusion, we found a trend in rural birds for dominants to outperform subordinates in a lever-pulling task, which may be explained by adults outperforming younger birds. Moreover, we found that rural birds were slightly more persistent in the paper-ripping task compared to birds from urbanised areas. Individual performance and persistence were not repeatable across tasks, and the traits defining the most innovative and persistent individuals in each task were not consistent, pointing to the need for experimental assessments on the effect of task characteristics on the repeatability of problem-solving performance and persistence. Overall, our findings suggest that different individual and ecological characteristics may facilitate innovative behaviour in different ecological contexts.