

Effects of nestling begging behavior on parental food provisioning in the Mountain
White-crowned Sparrow

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** figures, discussion, Rayleigh test results**

Abstract

Nestlings have evolved to communicate their status of need through visual and vocal begging displays. These behaviors allow nestlings to obtain resources, aiding in their chance of reproductive success. I predicted that increased intensity of nestling begging behavior would lead to increased rates of parental food provisioning. This was tested by monitoring Mountain White-crowned sparrow (*Zonotrichia leucophrys oriantha*) nests with cameras to collect both nestling and parent behavioral data. Linear regression analyses showed a significant but weak positive correlation between both the average gape and feeding frequency ($R^2 = 0.06021$, F-statistic = 3.075, p-value = 0.08587) and between average height and feeding frequency ($R^2 = 0.05924$, F = 3.023, p-value = 0.08851). Since there is variation among clutch size, a regression analysis of average feeding frequency in relation to the clutch size displayed a significant and strong negative correlation ($R^2 = 0.1099$, F-statistic = 5.927, p-value = 0.08851). To obtain more accurate results, two more separate linear regressions were conducted with a constant clutch size of three nestling showing a strong positive correlation between the average gape ($R^2 = 0.3457$, F-statistic = 11.62, p-value = 0.002516) and average height ($R^2 = 0.3997$, F-statistic = 14.65, p-value = 0.0009178) in relation to the feeding frequency. ****Rayleigh test results****

Introduction

Altriciality in passerine species, such as the Mountain White-crowned sparrow, is characterized by nestlings lacking down, sufficient mobility, and the ability to feed themselves (Ehrlich 1988). In a study concerning the energetic cost begging has on nestling passerines, it is mentioned that nestlings evolved to exhibit begging behaviors as a way to communicate their needs with parents as well as compete with siblings (McCarty 1996). Parents rely on these behaviors to determine how food is allocated within the brood, paying attention to displays as a way to gauge the individual status and level of need in each nestling (Grodzinski and Lotem 2007). Tree swallow (*Tachycineta bicolor*) nestlings exhibited begging behavior that correlated positively with hunger (Leonard and Horn 2000) as well as higher provisioning rates, if they reached higher, gaped sooner, and had the closest location to the parent (Leonard and Horn, 2000). Evidence to support this can be observed in studies of both brown-headed cowbird (*Molothrus ater*) (Dearborn 1997) and pied flycatcher (*Ficedula hypoleuca*) (Ottoosson et al. 1997) nestlings. These studies suggested that nestlings who produce the most exaggerated begging increase their chance of food provisioning.

In order to solicit resources from their parents, nestlings use visual and vocal signals to communicate need. Visual begging is characterized by the over-exaggeration of posture and opening the mouth widely. Mouth gape coloration, although variable between species, has been suggested to improve detectability of the young while also signaling need of resources (Kilner and Davies 1998). An example of this can be observed in canary nestlings (*Serinus canaria*) and barn swallow nestlings (*Hirundo rustica*) (Ayala et al. 2007), where the coloration of the mouth gape showed an increased intensity when the nestlings were more food deprived (Kilner and Davies 1998). Vocal begging has been found to make nestlings more competitive, and evidence from a study on Cory's Shearwaters (*Calonectric Diomedea*) found that larger meals were given to the nestlings with the most intense begging calls (Träger et al. 2006). In addition to visual and vocal begging, nestlings will also rearrange themselves competitively within the nest cup (Kölliker and Richner 2004). Great tit (*Parus major*) nestling were found to compete for positions within the nest cup that were closest to predictable parental feeding locations (Kölliker

and Richner 2004). **Exploring this behavior through the optimal foraging theory, it implies that nestlings who are able to secure optimal feeding locations would be able to maximize their fitness, as this method of solicitation would lower the energetic cost of begging (Kölliker and Richner 2004).**

By studying nestling begging in the Mountain White-crowned sparrow, we are able to gain a greater understanding of how behavior influences fitness (Verhulst and Wiersma 1996). It has been suggested that the aforementioned behaviors evolved in response to the parent-offspring conflict (Kölliker and Richner 2001), influencing nestlings to beg to increase their share of resources. Differences in weight among nestlings has been found to relate to fitness differences, revealing that there is a selective pressure on weight (Tinbergen and Boerlijst 1990). Observations of Great Tits who had a low weight as a nestling, were found to have a lower chance at securing a territory (Tinbergen and Boerlijst 1990). If the selective pressures, such as weight, driving natural selection are identified in a population, we can understand how behaviors influence an individual's reproductive prospects. This would imply, that nestlings who are the most successful at soliciting resources from their parents, have a higher reproductive value compared to its siblings.

The aim of this study was to investigate how nestling begging behavior influences parental food provisioning and if individual nestlings move positions within the nest cup in response to feeding rates. I predict that increased intensity of nestling begging behavior, would lead to increased rates of parental food provisioning, predicting that as the nestlings beg more, either to display need or for competitive purposes, these individuals will receive the most resources, and increase their future reproductive prospects.

Methods

Study Sites

This study was conducted in several locations in areas surrounding the Rocky Mountain Biological Laboratory (38.9585°N, 106.9877°W) in Gothic, Colorado. The study sites were located at several elevations from the East River Valley at 2800m to Schofield Park at 3300m, and the highest elevation sites located in North Pole Basin at 3700m. Classified as a montane ecosystem, vegetation is comprised of quaking aspens (*Populus tremuloides*), Engelmann Spruce (*Picea Engelmann*), various willows (*Salix spp*) and cinquefoil (*Potentilla spp*). This ecosystem also contains herbaceous species such as, Mountain bluebell (*Mertensia spp.*), buttercup (*Ranunculus acris*), monument plant (*Frasera speciosa*), and corn lily (*Veratrum spp.*).

Nest Searching and monitoring

To find nests, two techniques were used, passive and active nest searching in locations deemed suitable as nesting habitat (willow and cinquefoil). Locating nests passively required taking observations of parental behaviors and tracking their movements while the latter technique involved using a rope drag (12m) with attached aluminum cans to flush females off of their nests (Winter et al. 2003). Areas of interest were visually searched and located nests were marked with flagging 3m to the north and south of the nest, additionally the location was recorded with a Garmin Etrex GPS unit. To reduce disturbance, we quickly collected nest data, taking no longer than five minutes, and minimized possible predation by not creating dead end trails. Nest were

located at low elevation at sites 2 and 4, while high elevation nests were found in Schofield Park (Fig. 6)

Nests were monitored approximately every 2-4 days in order to track egg and nestling development. Measurements concerning the egg stage, number of nestlings, age of nestlings, time, parental activity, and if the nest is a failure or success were taken. A candling technique was used to determine the egg stage (Weller 1956). °

Nest Recording

To collect nestling behavior and parental food provisioning I used the method that is discussed in a paper on the depredation of Mountain White-crowned Sparrows (Troy and Conover 2019). Data collection involved using a GoPro Session camera that was mounted to a stake, tall enough to capture the entire nest within the frame. An ONN 20000 mAh external battery powered the GoPro connected with a cord about 3m long. The camera placement was as close to the nest as possible, as it was observed that there was a higher chance of abandonment when the camera was further away. To lower the chance nest abandonment, we waited to collect footage until nestlings were around 5-6 days old, also by this age nestlings are able to thermoregulate on their own (Morton 2002). This reduces the risk involved with the female being off the nest for long periods of time. Each nest was recorded for one day with the camera being placed around 0700h to 1400h and it was monitored by a researcher for several minutes to ensure that the parents do not abandon the nest due to the camera's presence.

Data analysis

There was a total of 16 nests analyzed in this study from the years 2017 and 2018. To analyze the nest footage, I recorded the time of day and the behaviors exhibited by the nestlings and parents each visit. The observed nestling behaviors were visual begging (exaggerated posture and mouth gape), and nest cup positioning. The parental behavior collected were the number of times a parent fed each individual and their location on the nest during each visit. To simplify data collection, I created an intensity scale for the visual begging behaviors. The mouth gape was scaled from 0-2 (0=closed, 1=partial, 2= fully open), while posture was a combination of body raising and neck stretching, scaled from 0-3 (0= no effort, 1 = partial effort, 2 = moderate effort, 3= high effort). Nestling position was determined by separating the body position from the mouth position during each feeding. Each nestling's body and mouth as well as the parent were assigned a location on the nest each visit. The nest was split into eight locations, 1, 1.5, 2, 2.5, 3, 3.5, 4, and 4.5. Each nest consisted of many 12-minute interval videos, ranging from 10-45 videos per nest. To ensure independency of the visual begging behavioral data, I randomly selected five videos from each nest, recorded every visit, and then divided the total number of visits by five, and ultimately five visits were analyzed from each nest. The average gape, height, and times fed were calculated for each nestling. When recording nestling positioning, every video of the selected nests had to be watched to recognize individuals and track their movements between videos.

A series of linear regressions were completed to determine the relationship between visual begging behaviors and parental food provisioning. The average mouth gape and average height for all nests were compared separately to the average number of times fed. A regression was conducted between the average times nestlings were fed in relation to the clutch size. To get more specific results for how begging behavior influences parental food provisioning, separate

regressions of the average mouth gape and average height compared to the average times fed were conducted with a constant clutch size of three nestlings. The nestling positioning was analyzed using a Rayleigh test to investigate if there is uniformity in nesting distribution in relation to the parents positioning during each visit.

Results

A total of five linear regressions were conducted, three included data from every nest and all 49 nestlings while the latter two held the clutch size constant at three nestlings and only 23 nestlings. The regressions conducted separately between average mouth gape and average height in relation to the average times fed both resulted in a significant but weak positive correlations. Average mouth gape had an $R^2 = 0.06021$, F-statistic = 3.075, p-value = 0.08587 (Fig. 1) and average height had an $R^2 = 0.05924$, F-statistic = 3.023, p-value = 0.08851 (Fig. 2). There was a significant and strong negative correlation between average times fed and the clutch size with an $R^2 = 0.1099$, F-statistic = 5.927, p-value = 0.01868 (Fig. 3). When the clutch size was held constant at three nestlings, the average mouth gape strongly correlated with average times fed with an $R^2 = 0.3457$, F-statistic = 11.62, p-value = 0.002516 (Fig. 4). Similarly, the average height also correlated strongly to average times fed when the clutch was held at three nestlings with an $R^2 = 0.3997$, F-statistic = 14.65, p-value = 0.0009178 (Fig. 5).

Discussion

This study sought to investigate how: 1) Nestling begging behavior influences parental food provisioning and 2) If individual nestlings move positions within the nest cup in response to feeding rates. I predicted that as nestlings increase the intensity of their begging, parents will respond by increasing the food provisioning. Since the average height and gape were too closely correlated, separate linear regressions had to be conducted against the average times nestlings were fed. Both yielded similar results, showing a direct positive relationship between increased intensity of begging and increased food provisioning, supporting the original prediction. Since Mountain White-crowned sparrow nest can vary in sizes, a linear regression was conducted between the average times fed and the clutch size. An inverse relationship was found, revealing that as the clutch size increased the average number of feedings for nestlings decreased. This suggests that although the nestlings may be exhibiting intense begging behaviors, they are less likely to secure resources in larger nests. In addition, when there are more nestlings, it has been observed that there is more competition and dishonesty among siblings. During footage analysis, it was not known if the nestlings were begging out of need (i.e., food deprivation) or if it was purely competitive. A study concerning the sibling competition in American robins (*Turdus migratorius*) found that when food deprived nestlings increased the intensity of their begging, they're not food deprived siblings also increased begging intensity in order to compete for resources (Smith and Montgomerie 1991). Responding to the variation in clutch size, two more linear regressions were conducted holding the clutch size constant. Again, separate regressions were conducted between average mouth gape and average height in relation to average times fed but this time only with clutches of three nestlings. Both regressions showed a strong positive correlation, revealing that in clutches of three, as begging intensity increased, so did the average times the nestlings were fed.

Figures

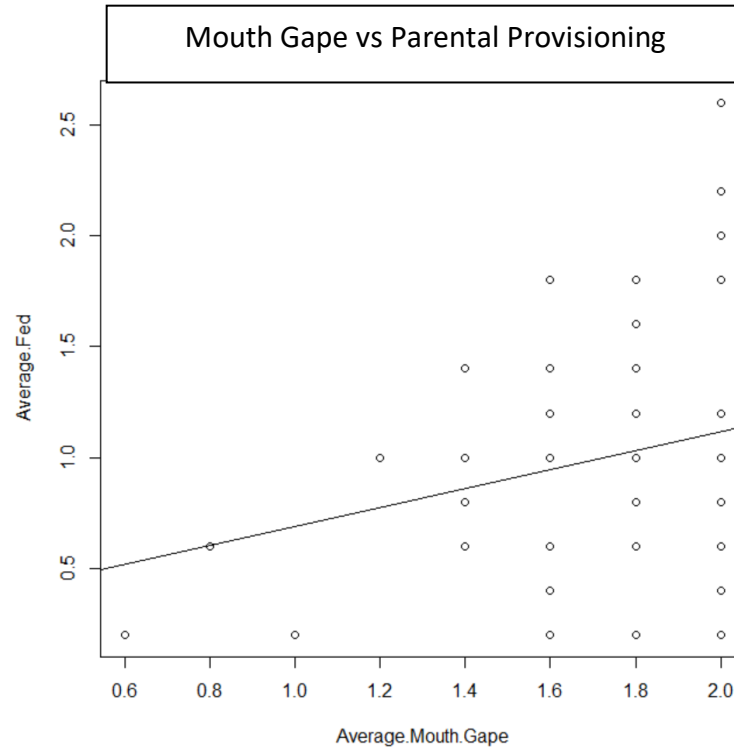


Figure 1. Average mouth gape compared to the average times nestlings were fed across all nests, with clutch sizes ranging from 1 to 4 nestlings. The linear regression showed a weak positive correlation with a p value of 0.08587.

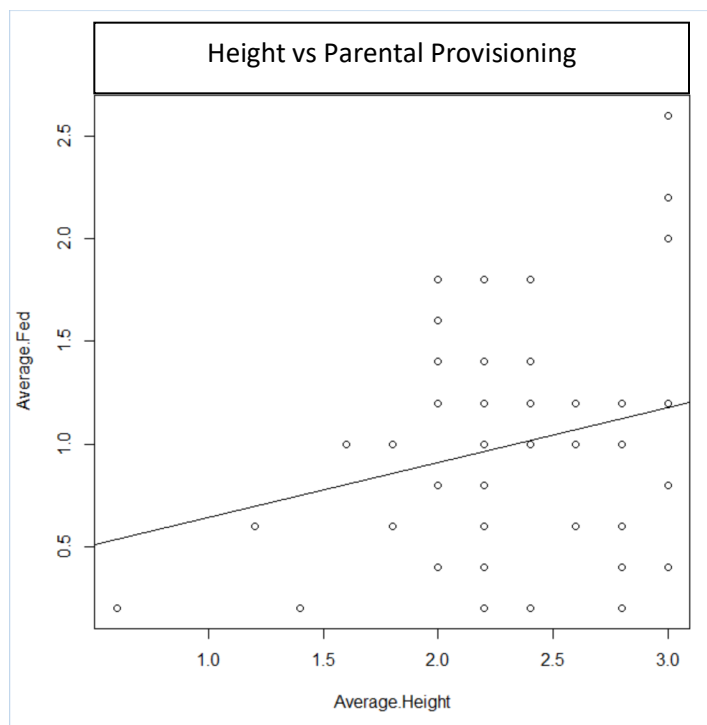


Figure 2. Average height, as a combination of neck exaggeration and body raising, compared to the average times nestlings were fed across all nests, with clutch sizes ranging from 1 to 4 nestlings. The linear regression showed a weak positive correlation with a p value of 0.08851.

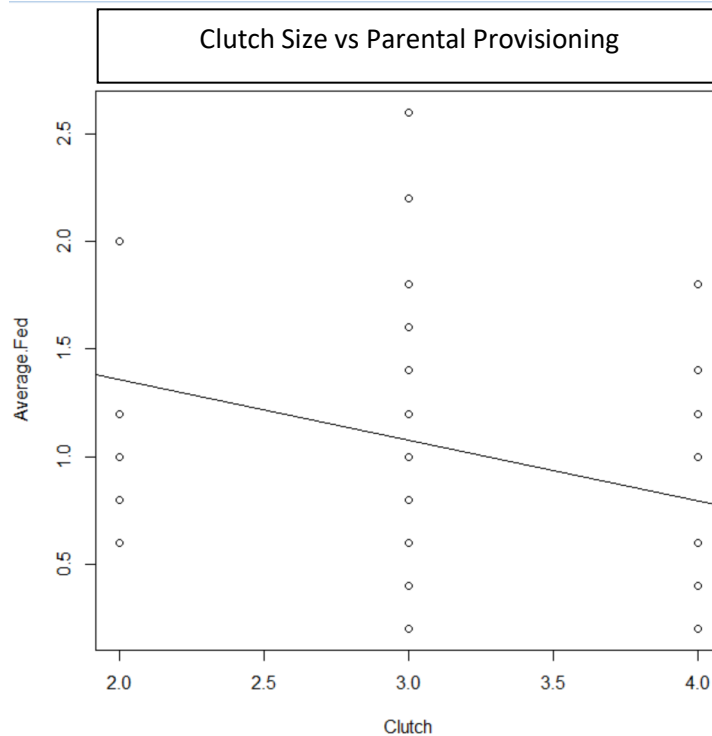


Figure 3. A linear regression of clutch size compared the average times nestling were fed. The test resulted in strong negative correlation with a p value of 0.01868, revealing parental provisioning decreases as the number of nestlings in a nest increases.

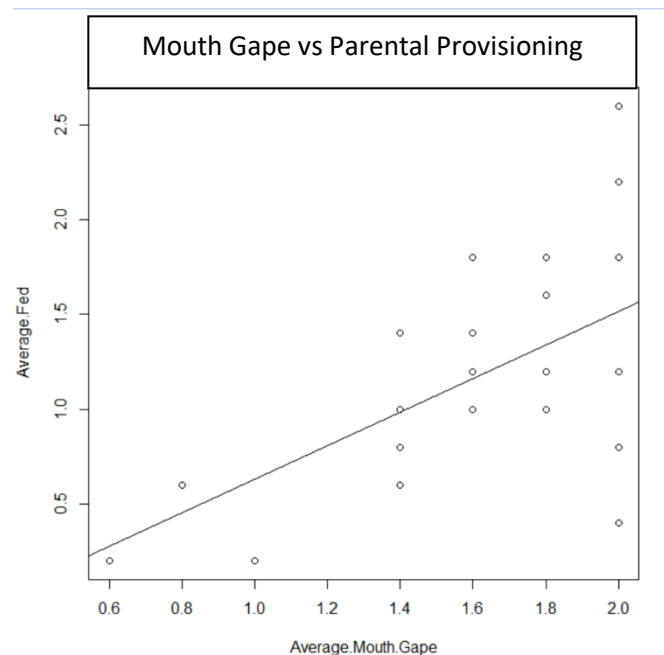


Figure 4. Average mouth gape, in only the nests of three nestlings compared to the average times nestlings were fed. The linear regression showed a strong positive correlation with a p value of 0.002516.

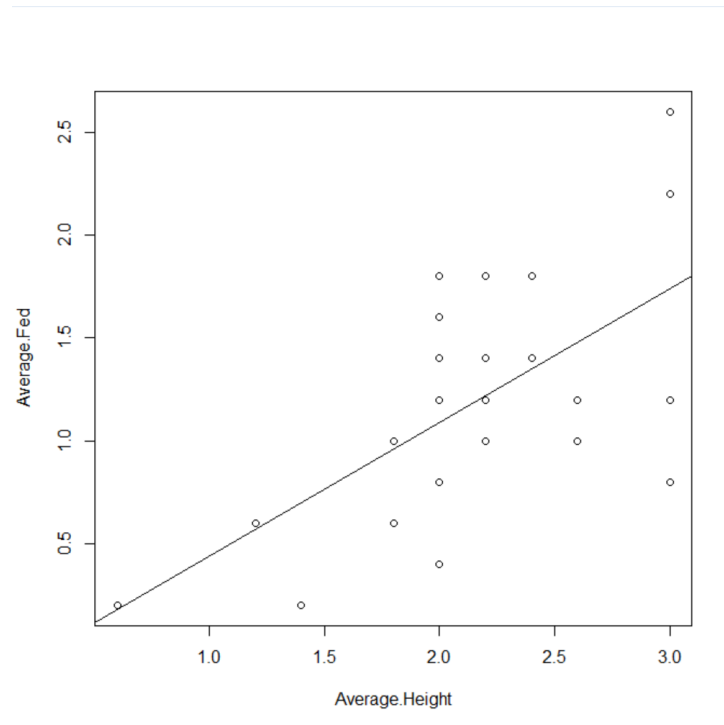


Figure 5. Average height, as a combination of neck exaggeration and body raising, in only the nests of three nestlings compared to the average times nestlings were fed. The linear regression showed a strong positive correlation with a p value of 0.0009178.

Literature Cited

- Ayala, R. M., N. Saino, A. P. Møller, and C. Anselmi. 2007. Mouth coloration of nestlings covaries with offspring quality and influences parental feeding behavior. *Behavioral Ecology and Sociobiology*.
- Dearborn, D.C. 1997. Begging behavior and food acquisition by brown-headed cowbird nestlings. *Behavioral Ecology and Sociobiology* 43: 259-270.
- Dugas, M. B. 2016. Baby birds do not always tell the truth. *PNAS* 113:13554-13556.
- Ehrlich, P. R. 1998. *The birder's handbook*. Simon & Schuster, New York, New York., USA.
- Grodzinski U., and A. Lotem. 2007. The adaptive value of parental responsiveness to nestling begging. *Proceedings of the Royal Society B: Biological Sciences* 274:2449-2456.
- Kliner, R. and N. B. Davies. 1998. Nestling mouth colour: ecological correlates of a begging signal. *Animal Behaviour* 56:705-712.
- Kölliker, M., and H. Richner. 2004. Navigation in a cup: chick positioning in great tit, *Parus major*, nests. *Animal Behaviour* 68:941-948.
- Leonard, M. L., and A. G. Horn. 200. Begging calls and parental feeding decisions in tree swallows (*Tachycineta bicolor*). *Behavioral Ecology and Sociobiology* 49:170-175.
- McCarty, J. P. 1996. The energetic cost of begging in nestling passerines. *The Auk* 113:178-188
- Morton, M. L. 2002. The mountain white-crowned sparrow: migration and reproduction at high altitude. *Studies in Avian Biology* 24.
- Ottoesson, U., and J. Bäckman, H. G. Smith. 1997. Begging affects parental effort in the pied flycatcher, *Ficedula hypoleuca*. *Behavioral Ecology and Sociobiology* 41:381-384.
- Pérez, J. H., J. S. Krause, H. E. Chmura, S. Bowman, M. McGuigan, A. L. Asmus, S. L. Meddle, K. E. Hunt, L. Gough, N. T. Boelman, et al. 2016. Nestling growth rates in relation to food abundance and weather in the Arctic. *The Auk* 133:261-272.
- Smith, H.G., R. Montgomerie. 1991. Nestling American robins compete with siblings by begging. *Behavioral Ecology and Sociobiology* 29: 307-312
- Träger, I., J. F. Masello, R. Mundry, and P. Quillfeldt. 2006. Do acoustic parameters of begging calls of Cory's Shearwaters *Calonectis Diomedea* reflect chick body condition? *The Waterbird Society* 29:315-320.
- Tinbergen, J. M., and M. C. Boerlijst. 1990. Nestling weight and survival in individual Great Tits (*Parus major*). *Journal of Animal Ecology* 59: 1113-1127
- Troy, S. R., and R. R. Conover. 2019. The depredation of Mountain White-crowned Sparrow (*Zonotrichia leucophrys oriantha*) nests by the golden-mantled ground squirrel (*Callospermophilus lateralis*) and long-tailed weasel (*Mustela frenata*). *The Wilson Journal of Ornithology* 131:629-633.
- Verhulst, S., and P. Wiersma. 1996. Is begging cheap?. *The Auk* 114: 134-134

Weller, M. W. 1956. A simple field candler for waterfowl eggs. *The Journal of Wildlife Management*. 20: 111-113

Winter, M., S. E. Hawks, J. A. Shaffer, and D. H. Johnson. 2003. Guidelines for finding nests of passerine birds in tallgrass prairie. *The Prairie Naturalist* 35.