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### Black-capped Chickadees and Red-breasted Nuthatches “Weigh” Sunflower Seeds

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Chickadees and nuthatches that come to feeders in the winter commonly select a seed and then fly off with it to hammer it open in a secluded spot (Lima 1985). Given that flying to and from an open feeder may be risky (Barkan 1990) as well as cost time and energy, a bird feeding on sunflower seeds should discriminate among seeds and select those that provide the most food reward (Lima 1985). However, sunflower seeds are enclosed in hulls, and many seed hulls are empty, even though they may be of similar size and appearance to filled hulls. Nevertheless, seed size and shape are criteria used by birds for seed choice (Willson 1972). Here, we demonstrate that Black-capped Chickadees (*Parus atricapillus*) and Red-breasted Nuthatches (*Sitta canadensis*) take sunflower seeds selectively and discriminate between them on the basis of heft.

This study was conducted in January 1996 at two sites near Weld, Franklin County, Maine. Site 1 was a feeder erected in the forest for the first time at the beginning of this study. Site 2 was a nearby (0.8 km away) pre-existing feeder that had already been continuously supplied with sunflower seeds and that was frequented by at least 50 chickadees and more than 6 nuthatches throughout this study. The nuthatch observations were made at this site only. We experimented with five types of striped sunflower seeds of similar linear dimensions: (1) normal (randomly chosen, filled, unshelled), (2) empty (resembled normal but with contents removed), (3) filled (empty seeds filled with Bondex plaster of Paris), (4) large, and (5) small. Average masses ( $\pm$ SD) of regular (unaltered), empty, filled, large, and small seeds were  $73 \pm 21.9$ ,  $25 \pm 10.0$ ,  $127 \pm 28.1$ ,  $104 \pm 31.6$ , and  $43 \pm 12.2$  mg, respectively.

In order to test whether the birds weighed seeds, we removed the normal feeder (with unmanipulated striped sunflower seeds where the birds fed just prior

to any one test) and simultaneously provided two piles of similar seeds 20 cm apart on a feeding board. The positions of seed piles were regularly shifted on the feeding boards in repeated trials. Tests consisted of: (1) normal versus empty, (2) normal versus filled, and (3) large versus small seeds. Because different birds visited our feeding boards we recorded the seed pile visited, how many seeds were discarded (picked up and flung aside), and how many were taken. We assumed the birds had prior experience with empty versus small and large filled seeds. We predicted that if the birds discriminated seeds on the basis of mass, then they should discard empty seeds and show high preference for heavier plaster-of-Paris filled seeds, and possibly also discriminate smaller differences in mass (e.g. normal vs. plaster-filled seeds, and small vs. large seeds).

*Red-breasted Nuthatch.*—We recorded 11 nuthatch visits to the normal seeds in the normal versus empty seeds experiment. During six of these visits the birds did not discard any seeds, and only once did they discard more than two seeds. The number of visits to the empty seeds was nearly identical (10). However, in this case all but one visit involved discards. In one visit a bird discarded 9 seeds in a row, and in 7 of the 10 visits, the nuthatches did not take any seeds from the pile with empties. The mean number of seeds discarded per visit was  $0.73 \pm$  SD of 0.90 for normal and  $2.82 \pm 0.54$  for empty seeds, a significant difference ( $t = 2.24$ ,  $df = 19$ ,  $P < 0.05$ ).

In the converse experiment, when nuthatches were exposed to normal versus filled seeds, they again selectively took the heavier seeds. They discarded seeds in 14 of 21 visits to the normal pile, and in 10 of 20 visits to the pile of heavy seeds. Almost every visit to both types of seed concluded with taking (leaving with) a seed. Mean numbers of seeds discarded were 2.14 pm 2.13 for unaltered and  $0.75 \pm 0.91$  for heavy

seeds, a significant difference ( $t = 2.74$ ,  $df = 39$ ,  $P < 0.01$ ). However, when presented with small versus large seeds, the mean number of discards was nearly identical (1.92 vs. 1.81 for small and large seeds, respectively;  $t = 0.16$ ,  $df = 27$ ,  $P > 0.05$ ).

*Black-capped Chickadee, site 1.*—We recorded 71 chickadee visits to the normal seeds versus 59 visits to the empty seeds in the normal versus empty seed trials. In one visit a chickadee discarded 13 empty seeds in a row before leaving with one. On the normal seed pile (of unsorted seeds) discards never exceeded three. The mean number of empty seeds discarded was  $2.75 \pm 2.80$  versus  $0.69 \pm 0.82$  for regular unsorted (but full) seeds, a significant difference ( $t = 5.45$ ,  $df = 128$ ,  $P < 0.01$ ). Chickadees made 56 visits to the heavy seeds versus 60 visits to the normal seeds when seeds filled with plaster of Paris were tested against normal seeds. Only 4 of the 56 visits to heavy seeds resulted in a seed discard. At the normal seeds, on the other hand, chickadees discarded seeds during 44 of 60 visits. The mean number of discards per visit for normal versus plaster of Paris seeds was  $1.32 \pm 1.3$  and  $0.07 \pm 0.26$ , respectively, a significant difference ( $t = 7.51$ ,  $df = 114$ ,  $P < 0.01$ ).

When confronted with small versus large seeds, chickadees (unlike the nuthatches) selectively discarded small but normal seeds. The mean number of discards was  $0.86 \pm 1.0$  versus  $0.47 \pm 0.80$  for small and large respectively, a significant difference ( $t = 4.07$ ,  $df = 136$ ,  $P < 0.01$ ).

*Black-capped Chickadee, site 2.*—The results for normal versus empty seeds were similar to those from site 1. The mean number of empty seeds discarded was  $2.04 \pm 1.65$  for 45 visits, versus  $0.33 \pm 0.77$  for 49 visits to regular seeds ( $t = 6.3$ ,  $df = 92$ ,  $P < 0.01$ ). Similarly, the mean number of discards for normal seeds was  $0.62 \pm 0.92$  versus  $0.14 \pm 0.53$  for filled seeds, a significant difference ( $t = 7.5$ ,  $df = 124$ ,  $P < 0.01$ ). The mean number of discards for large ( $0.51 \pm 1.03$ ) versus small ( $0.92 \pm 1.56$ ) seeds also was different ( $t = 2.13$ ,  $df = 115$ ,  $P < 0.05$ ).

The above experiments show that both nuthatches and chickadees discriminate in favor of heavier over lighter sunflower seeds. Both species of birds have an approximately four-fold tendency to discard empty seeds before taking one when confronted with empty versus normal filled seeds. These results alone do not distinguish whether the birds distinguish between empty and full seeds on the basis of "squishability." However, we found that normal (unaltered) seeds were rejected at a high rate when chickadees were given a choice of normal versus filled (plaster of Paris) seeds. Chickadees exhibited a slight (but still significant) tendency to discriminate between small and large sunflower seeds. The nuthatches approximately tripled their rejection rate of normal seeds when con-

fronted with filled versus normal seeds. Similarly, chickadees doubled their rejection rate under the same conditions. Because the filled seeds were incompressible (as were normal seeds) yet still accepted, we conclude that the birds compare mass in addition to or in favor of other possible cues.

Chickadees can learn to discriminate heavy from lighter seeds if the seeds are color-coded (Hawks 1983, Hutchins 1989), and they also can associate food with other indirect visual cues (Heinrich and Collins 1983). Previous work indicates that Clark's Nutcrackers (*Nucifraga columbiana*) discriminate good from bad piñon seeds on the basis of color (Vander Wall and Balda 1977) as well as by "bill-clicking" to detect auditory cues (Johnson et al 1987), and Piñon Jays (*Gymnorhinus cyanocephalus*) are thought to select seeds based on mass in addition to visual and auditory cues (Ligon and Martin 1974). Our results show that both Black-capped Chickadees and Red-breasted Nuthatches can discriminate seeds by heft alone.

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