

In all likelihood, the head-up, tail-up post-copulatory display by male birds is used in agonistic situations relating to the constant solicitation display of the dummy female. Aspects of the display, especially tail-up, while facing away from an opponent, suggest a high degree of appeasement function in agonistic circumstances.

Performance of head-up, tail-up display in flight by a male Indigo Bunting (*Passerina cyanea*) towards a human supports the suggestion of the use of female solicitation behavior by males under stress in agonistic situations. On 10 July 1971, near East Braintree, Manitoba, both members of a pair of Indigo Buntings appeared and reacted to me as if they had fledglings in the vicinity. Several times when I "pished," the male flew toward me in stilted flight, head and tail up, wings held partly open at the sides and fluttering.

Marler (Behaviour Suppl. 5, 1956:118) described use of the female precopulatory or soliciting posture by male Chaffinches (*Fringilla coelebs*) when confronted by dominant males. The postures of the submissive birds were "identical with the high intensity soliciting posture of the female." Judging from the photos of the latter display, Marler's (1956) submissive males had postures nearly identical to that of Lark Buntings in post-copulatory display. The use of female soliciting posture by male Chaffinches was "associated with a strong escape tendency that is prevented from expression" (Marler 1956:119). Marler (1956:121) notes further that in male-male confrontations "the most elaborate display is associated with the highest intensity of conflict." The post-copulatory display of the Lark Bunting, Chestnut-collared and McCown's longspurs appears to be of this nature. Although elicited by an artificial stimulus source (the dummy bird) these displays must be regarded as a genuine part of the behavioral repertoire of the species, significant in terms of motivation, latent with meaning, and beautiful.

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**Responses of Black-capped Chickadees to mirrors.**—The use of mirrors is of interest in studying agonistic and social behavior (Svendson and Armitage, *Ecology* 54:623–627, 1973). Several species of birds have been tested in the laboratory (e.g., Zebra Finch [*Poephila guttata*], Ryan, *Wilson Bull.* 90:295–297, 1978; House Sparrow [*Passer domesticus*] and Budregriar [*Melospittacus undulatus*], Gallup and Capper, *Anim. Behav.* 18:621–624, 1970). The only species of free-living birds that have been presented with mirrors are Glaucous-winged Gulls (*Larus glaucescens*) (Stout et al., *Behaviour* 34:29–41, 1969) and Blue Grouse (*Dendragapus obscurus*) (Stirling, *Can. J. Zool.* 46:405–408, 1968).

Here we examine reactions to mirrors of free-living Black-capped Chickadees (*Parus atricapillus*) in winter flocks. We asked the following questions: (1) How do chickadees respond to mirrors? (2) Do responses reflect differences in dominance rank?

In winter Black-capped Chickadees live in small flocks and exhibit a linear dominance hierarchy (e.g., Glase, *Living Bird* 12:235–267, 1973). Displays associated with aggressive interactions include various postures, gaping, and a vocalization termed the "gargle" (Ficken et al., *Auk* 95:34–48, 1978). In natural encounters only the more dominant males give this vocalization frequently.

Experiments were conducted at the University of Wisconsin–Milwaukee Field Station, Saukville, Ozaukee Co., Wisconsin, from January to March 1979. Observations were made from blinds located 10 m from two feeders, D7 and F9. The two feeders were identical in

TABLE 1  
RESULTS OF MIRROR EXPERIMENTS AT D7 FEEDER

Individuals <sup>a</sup>	No. visits in which seeds were taken				No. seeds/visit mirror <sup>b</sup>	No. visits when threats given to mirror
	baseline	mirror	baseline	foil		
PCAO ♂	3	0	1	0	0 (5)	—
JACO ♂	12	7	9	6	0.44 (16)	2
AOYR ♂	9	0	10	0	0 (11)	—
ASYO ♂	3	2	1	4	1 (2)	—
WYAO ♂	12	3	17	2	0.15 (20)	3
AOJJ ♂	5	0	10	5	0 (4)	—
AOCR ♂	2	1	0	0	0.5 (2)	1
ROJA ♂	1	0	0	0	0 (6)	—
AOCC <sup>c</sup>	10	11	13	1	0.5 (19)	—
ABPO ♂	0	0	0	0	0 (3)	—
WBAO ♂	2	0	21	5	0 (5)	—
BOAB <sup>c</sup>	0	0	7	3	0 (1)	—
RSAO ♀	1	2	0	0	0.33 (6)	—
YCAO ♀	30	0	17	2	0 (12)	—
PABO <sup>c</sup>	8	0	3	2	0 (8)	—
RGAO ♀	12	0	11	3	0 (4)	—
RAGO ♂	3	0	0	0	0 (3)	—

<sup>a</sup> Listed in order of dominance.

<sup>b</sup> Total number of visits in parentheses.

<sup>c</sup> Sex unknown.

design but separated by about 100 m. Several flocks visited each feeder. The feeders had two perches but only one bird fed at a time. The chickadees were individually color banded.

Two mirrors were used in the experiments, both 15.2 cm in diameter, but one was covered with aluminum foil so that while a shiny and novel object was presented, a bird could not see its image. For each presentation one of the two "mirrors" was placed in the feeder near the sunflower seeds so that an approaching bird would be confronted by it. Each feeder received three presentations of each "mirror" in random order, at intervals of 1 week (to reduce habituation). Prior to any presentation a 15-min baseline sample of behavior was obtained that included a recording of the number of times the feeder was visited by each individual and whether food was obtained. The mirror or foil was placed in the feeder for 15 min following the baseline and the same data were recorded. Data and vocalizations were recorded on a Uher 4200 tape recorder using an Electrovoice 644 microphone. Vocalizations were analyzed with a Kay 6061B Sona-Graph.

Data on natural, aggressive interactions at the two feeders were also obtained in the same winter and dominance hierarchies were determined. A bird was considered to be dominant over another if it won an encounter or if one bird arrived after another but was the first to feed.

The behavior of chickadees was changed markedly by the mirror. When the mirror was absent a bird typically landed on the perch, entered the feeder and took a seed. When the mirror was present a bird usually landed and hopped from perch to perch several times and sometimes left without obtaining a seed. The experimental results for D7 feeder are shown

TABLE 2  
RESULTS OF MIRROR EXPERIMENTS AT F9 FEEDER

Individuals <sup>a</sup>	No. visits in which seeds were taken				No. seeds/visit mirror <sup>b</sup>	No. visits when threats given to mirror
	baseline	mirror	baseline	foil		
COAY ♂	8	0	6	1	0 (5)	—
BOAW ♂	12	3	16	4	0.17 (18)	2
AOYB ♂	3	1	0	0	0.25 (4)	—
WPAO ♂	4	2	1	7	0.5 (4)	—
RYAO ♂	5	0	10	10	0 (2)	—
ROBA ♂	12	8	12	16	0.53 (15)	3
BRAO ♂	11	8	6	14	0.42 (19)	2
CBAO <sup>c</sup>	6	6	0	3	0.83 (7)	4
TOAT ♂	1	0	7	7	0 (2)	—
BACO ♀	0	0	7	6	0.15 (13)	—
RTAO ♂	7	0	5	3	0 (4)	—
AWYO ♂	1	0	8	2	0 (4)	—
AOSP ♂	8	2	1	1	0.25 (8)	—
JTAO ♂	1	0	2	2	0 (2)	—
AYRO ♀	9	1	4	7	0.13 (7)	—
POYA ♂	7	1	10	16	1 (1)	—
ACYO ♀	2	2	7	14	0.67 (3)	—
PORA ♂	2	0	3	1	0 (1)	—
GOAS ♀	3	0	0	0	0 (4)	—
AOYW ♀	9	0	1	1	0 (1)	—
AOPY ♀	5	0	0	2	0 (6)	—
BBAO ♀	1	0	2	2	0 (6)	—
COAJ ♀	5	0	2	8	0 (4)	—
ARCO ♀	3	0	0	0	0 (4)	—

<sup>a</sup> Listed in order of dominance.

<sup>b</sup> Total number of visits is in parentheses.

<sup>c</sup> Sex unknown.

in Table 1, for F9 in Table 2. The number of visits when seeds were taken with the mirror present was significantly lower as compared to the baseline at both feeders ( $P < 0.001$  for F9,  $P < 0.005$  for D7, Wilcoxon test, one-tailed). When the baseline was compared with the foil there was a significant difference ( $P < 0.05$ ) for D7 but not for F9 ( $P > 0.05$ ). When the number of seeds taken with the mirror present was compared directly to the number of seeds taken when the foil was present the difference was significant at both feeders ( $P < 0.005$ ). The birds tended to take fewer seeds when either mirror or foil was present, but feeding was depressed more by the mirror.

In some cases threats, consisting of "gargles" and gapes, were directed at the mirror. Seven individuals (six males, one sex unknown) threatened the mirror; all were in the top half of their dominance hierarchy (Tables 1 and 2). "Gargles" vary in their syllabic composition, but the "gargles" at the mirror were not different from those typically given by that individual in natural encounters.

We also tested the hypothesis that dominant birds would take more seeds per visit with

the mirror than more subordinate birds. This hypothesis was not supported ( $P > 0.05$ , Kendall's tau).

The way in which a chickadee responds to its reflection depends in part on its past experiences in agonistic encounters and is reflected in its dominance rank. Birds that were more successful in winning contests were more likely to threaten the mirror, although threats were not confined to the most dominant birds as some males of mid-rank threatened the mirror. Even dominants tended to take fewer seeds when confronted with a mirror, indicating that they were somewhat intimidated.

A number of experiments with birds have employed models (e.g., Lack, *Life of the Robin*, Penguin Books, London, England, 1953; Dilger, *Auk* 73:313–353, 1956). A model is an unchanging stimulus, while a mirror reflects the animal's behavior exactly, except for vocalizations. Thus, a dominant bird sees one responding like a dominant, a subordinate sees one that acts like a subordinate. For birds with visual individual recognition the image would be a stranger. Mirror experiments are often difficult to interpret (Smith, *The Behavior of Communicating: An Ethological Approach*, Harvard Univ. Press, Cambridge, Mass., 1977), but they do show what an animal will do when confronted with an animal that looks and acts like itself. However, the image does not act like a copy because vocalizations are not returned, and this may be a very important difference for a species such as the chickadee which uses vocalizations frequently in agonistic encounters. However, our data show that chickadees will threaten a visual stimulus that is not accompanied by a vocal component.

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**Tool use by Green Jays.**—Tool use by birds has usually been defined as the manipulation of inanimate objects so as to extend the physical capabilities of the bird (Morse, *Behavioral Mechanisms in Ecology*, Harvard Univ. Press, Cambridge, Massachusetts, 1980). Corvids that use tools include the New Caledonian Crow (*Corvus moneduloides*) (Orenstein, *Auk* 89: 674–676, 1972), and laboratory-reared Blue Jays (*Cyanocitta cristata*) (Jones and Kamil, *Science* 180:1076–1078, 1973). Here I report tool use in the Green Jay (*Cyanocorax yncas*).

While studying this species at the Santa Ana National Wildlife Refuge near Alamo, Texas, I saw use of "tools" by a family of adult and juvenile Green Jays on 6 June 1981. I first observed an adult Green Jay (sex unknown) on the ground pick up a small twig in its beak and fly to a branch of a dead tree approximately 4 m above the ground. The bird inserted the twig under a piece of bark and moved it back and forth for approximately 5 sec. The jay then withdrew the twig, placed it under its feet, and proceeded to consume an insect that was attached to the twig. The bird then reinserted the twig under the bark and repeated the sequence of events four consecutive times, lasting about 2 min. The jay dropped the twig and flew a short distance to another tree. A few minutes later, the same adult flew back to the branch with another short twig in its beak and again inserted it under the bark. This time, however, the bird pried off a piece of bark, dropped the twig, and consumed the exposed insects. Whether the jay intentionally used the twig as a lever in this instance is unknown, since this behavior was not observed again.

A juvenile Green Jay attempted to use twigs to capture insects in a similar manner. One