Tactical deception reduces predation on birds' eggs

Daniel T. Blumstein[1]

Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA 90095-1606

> All warfare is based on deception.
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> Sun Tzu, Chapter 1, *The Art of War*

In the months leading up to the 1973 Yom Kippur War, the Egyptian military staged 40 maneuvers on or near the Israeli border. Over time, the Israelis learned that Egyptian activity near the border was not necessarily a threat to respond to, and they ultimately let their guard down, only to be surprised one day when the tanks and troops crossed the border as part of a coordinated invasion (1, 2). In PNAS, Price and Banks (3) show that by using analogous tactical deceptions that rely on teaching animals not to expect to find food, conservation biologists might be able to reduce predation on vulnerable ground-nesting birds.

Conservation biology is a crisis discipline that is often at war with forces that push species toward extinction. Indeed, a major problem that has resulted from our systematic killing of carnivores throughout the world is that we have created disequilibria that let former prey prosper (4). When those prey include potentially harmful predators, such as rats (*Rattus* sp.) or hedgehogs (*Erinaceus europaeus*), that may eat bird eggs and nestlings, ground-nesting birds may be the ultimate losers in this trophic cascade (5, 6).

Conservation interventions may include attempting to kill all the predators, which raises ethical issues and is often difficult to accomplish. Nonlethal interventions include captive breeding and reintroduction to recover populations. However, many of these interventions fail (7). Failures are costly and mean that the population is not rescued or recovered. Thus, research to reduce failures and create new nonlethal means to recover vulnerable populations is ultimately a boon to conservation and welfare.

Conservation behavior is a subdiscipline of conservation biology that applies fundamental insights from behavioral biology to conservation (where the goal is typically to increase small populations) and management (where the goal is typically to decrease overabundant populations or reduce their deleterious effects) (8). Many conservation and management problems can benefit from mechanistic insights into how animals respond to stimuli and learn about biologically important events.

Previous Deceptions

Organisms produce smells, and these unique scents may contain potential information about species, sex, age, identity, and reproductive status. Importantly, both conspecifics and heterospecifics may use these scents to make biologically informed decisions, and learning is often an important mechanism in decision making. It is generally known that hunters try to attract predators with the scents of their prey, trappers try to attract animals

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with the scents of their conspecifics, and gardeners try to repel herbivores with the scents of their predators. However, conservation biologists also have used scents to manipulate the behavior of focal species.

There are a number of instances in which conspecific scents have been used to manipulate the behavior of threatened or endangered species. For instance, in a captive breeding situation, researchers preexposed female pygmy lorises (*Nycticebus pygmaeus*) to the scents of a male that they wished the females to mate with and, by doing so, increased the likelihood that the genetically appropriate male sired young (9). Another study that targeted conspecific learning of olfactory signals sought to reduce mortality of recently introduced black rhinoceroses (*Diceros bicornis*), which were often killed by resident rhinos soon after release (10). The researchers reasoned that if residents thought that the new rhinos were already residents, "dear enemy" processes, whereby residents tolerate a known neighbor but fight unknown neighbors (11), might be created. Thus, they set out to preexpose resident rhinos to the scents of the individuals about to be introduced by taking feces from the soon-to-be-released residents and spreading them around the landscape (12). Although the rhino study was initially unsuccessful, this and the loris study showed that such innovative adaptive management based on a fundamental understanding of how animals use conspecific scents when making biologically important decisions could generate novel conservation interventions.

Price and Banks (3) took these deceits a step further and sought to manipulate the predator's perception of the amount of food in a foraging patch. They focused on the information-rich olfactory cues that prey inadvertently leave for their predators. They capitalized on the insight that predators, when searching for prey, learn to discount unrewarding searches, and by doing so, focus their efforts on patches that are more likely to contain prey. After all, experienced predators that allocate their time efficiently should not forage in unrewarding patches.

New Deceptions

Price and Banks (3) cleverly designed an experiment to capitalize on this phenomenon to see if by training predators to assume that a particular patch was unrewarding, they could later introduce potentially vulnerable prey, and thereby increase the survival of those prey. They used domestic quail (*Coturnix coturnix japonica*) eggs as a model system to simulate ground-nesting birds, and they used the olfactory cues left over in their nests (feathers and feces) to try to dupe black rats (*Rattus rattus*), an invasive species at their eastern Australian study site, into searching elsewhere for food.

Pilot studies showed that their study sites in two national parks in and around Sydney, Australia had about 25 rats per hectare. They experimentally manipulated three factors: the timing of prey and odor introduction, the odor's spatial distribution (they referred to this as chemical camouflage and either distributed odors throughout their grid or where the nests were), and the nest layout

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[1]E-mail: marmots@ucla.edu.

(a form of visual camouflage, where they distributed artificial nests made from a tennis ball either randomly or in a matrix). Nests either had a quail egg and a plasticine egg in them or two plasticine eggs (plasticine eggs allowed them to identify putative predators by their tooth marks and to exclude predation by species other than rats). The influence of timing of prey and odor introduction was tested by preexposing the rats to prey odors for 7 d without adding prey. After 7 d of preexposure, they put nests out in control and treatment patches.

They found that eggs in patches that had been preexposed to 7 d of unrewarding olfactory quail cues had 62% higher survival over the next 7 d than eggs in patches in which the prey and the odor were introduced concurrently. Interestingly, they found no difference in the effect of either olfactory or visual camouflage; this pattern of observations was most consistent with the olfactory learning hypothesis.

As the authors succinctly conclude, "[these] findings expand the relevance of predator learning and sensory perception as selective forces within olfactory systems, revealing that subtle changes in predator motivation to pursue cues can benefit prey survival" (3). Importantly, if this can be made to work in an applied setting with a threatened or endangered population, the authors have added a potentially important nonlethal tool to our applied wildlife conservation armamentaria. Sun Tzu would be proud.

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