

## Research Report

### TRUE IMITATIVE LEARNING IN PIGEONS

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**Abstract**—Providing evidence for imitative learning in animals has been made difficult by the need to control for a number of possible nonimitation accounts (e.g., mere presence of another animal, attention drawn to a location, attention drawn to an object being manipulated) that often have not been recognized in previous research. In the present experiment, we used a version of the two-action method in which a treadle could be operated by a pigeon in one of two distinctive ways: with its beak by pecking or with its foot by stepping. What is unique in this experiment is not only the distinct response topographies, but also that both responses have the same effect on the environment (depression of the treadle followed by food reward). When pigeons that had observed one of the two response topographies were given access to the treadle, a significant correspondence was found between the topography of the observers' responses and that of their respective demonstrators' responses.

Imitative learning in animals has attracted considerable recent research interest (see, e.g., Heyes & Galef, 1996; Zentall & Galef, 1988), in part because of its cognitive implications. For example, it has been suggested that evidence that an animal can acquire a response having observed the response made by a demonstrator may indicate that the observer "understands" how it looks itself when making the same response (see Zentall, 1996).

A number of examples of imitation by animals have been reported in the literature. For example, Gardner and Gardner (1969) reported that Washoe, a chimpanzee, would bathe a doll in much the same way that she had been bathed by humans. Similarly, Breuggeman (1973) reported observing a young female rhesus monkey clasp a piece of coconut shell to her stomach in the same manner as her mother clasped the young monkey's infant brother. Finally, Russon and Galdikas (1993) reported that orangutans living free in a rehabilitation center manipulated human artifacts in humanlike ways, such as brushing teeth, using a knife, sharpening an axe, and applying insect repellent.

To recognize the relation between one's own behavior and that of another appears to require what developmental psychologists refer to as point of view or perspective taking (Piaget & Inhelder, 1948/1967). Although perspective taking does not appear to be within the cognitive capacity of laboratory animals such as rats and pigeons, considerable research on imitation learning has been conducted with these species (see, e.g., Galef, 1988; Zentall, 1996). Before one can claim that rats or pigeons are capable of imitative learning, however, one must rule out nonimitative factors (see Galef, 1988; Thorpe, 1963; Tomasello, 1996; Whiten & Ham, 1992; Zentall, 1988).

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One paradigm that has been used to study socially transmitted learning involves the association of a nominally neutral object with fear. According to Mineka and Cook (1988), laboratory-reared monkeys that are exposed to a toy rubber snake show little evidence of fear, whereas wild-reared monkeys often show a clear aversion to the toy. If a wild-reared monkey is exposed to the toy snake in the presence of a laboratory-reared monkey, fear of the snake is readily transmitted to the previously unaffected laboratory monkey. However, most researchers would not classify this example of social transmission as imitation because it could be explained in simpler terms. First, fear can readily be transmitted from one animal to another through a process that Thorpe (1963) called contagion. Second, the association of the putative neutral snake with fear could occur through the Pavlovian pairing of the two (see Whiten & Ham, 1992). That fear of snakes is more readily transmitted from one animal to another than fear of other stimuli (e.g., flowers; Mineka & Cook, 1988) suggests that animals may be predisposed or prepared to make some associations rather than others (humans readily develop a fear of the dark, whereas they rarely develop a fear of electrical outlets; Seligman, 1972). Thus, most imitation experiments with animals have been conducted in appetitive, rather than aversive, contexts.

In the simplest form of such an experiment, one asks, for example, if giving a rat the opportunity to observe another rat bar pressing for food reward results in faster acquisition of bar pressing than if the rat had to acquire the response in isolation (i.e., a trial-and-error control). However, motivational changes produced by the mere presence of another rat (i.e., social facilitation; Zajonc, 1965) could account for such facilitated acquisition.

Furthermore, in exposing an observer to a bar-pressing demonstrator, one may merely draw the observer's attention to the demonstrator, and consequently draw the observer's attention to the location of the bar (a phenomenon known as local enhancement; Thorpe, 1963). Attempts have been made to avoid local enhancement by separating the demonstrator's bar from that of the observer using the duplicate-cage procedure (Warden & Jackson, 1935; Zentall & Levine, 1972). Then, if the observer's attention is drawn to the demonstrator and its bar, the observer's attention should be drawn away from the observer's own bar—an outcome that should lead to retarded acquisition. But, typically, the observer's bar is quite similar to that of the demonstrator. Thus, it is possible that the observer's attention will be drawn not only to the demonstrator and its bar, but also to the observer's own bar (a phenomenon that has been called stimulus enhancement; Galef, 1988; Spence, 1937).

Control procedures for stimulus enhancement effects are difficult to design because the appropriate control group is not obvious. One approach, suggested by research by Dawson and Foss (1965), is to identify a task that can be accomplished in more than one way (e.g., the two-action method; Whiten &

## Imitation in Pigeons

Ham, 1992). Dawson and Foss found that each of a group of budgerigars (members of the parrot family) learned on its own to remove a flat lid from a food cup in one of three different ways: by pushing the lid off with the beak, by twisting it off with the beak, or by twisting it off with the foot. These birds then served as demonstrators for another group of budgerigars. After exposing each of five observers to a demonstrator, Dawson and Foss found that the responses of each observer matched those of its demonstrator (see also Galef, Manzig, & Field, 1986). Heyes and her colleagues (Heyes & Dawson, 1990; Heyes, Jaldow, & Dawson, 1994) recently developed a version of the two-action method (called the bidirectional control procedure) that they used to examine imitative learning in rats. Demonstrators were trained to push an overhead pole either to the left or to the right. When observers that had been exposed to the demonstrators were given access to the pole, they tended to push the pole in the same direction as their respective demonstrators.

The bidirectional control procedure provides the best evidence for true imitative learning (i.e., imitation that is free from the artifacts already mentioned) in animals in an instrumental setting. Ideally, however, to rule out all possibility of stimulus enhancement effects, one should expose observers to two different responses that differ only in their topography and not in the differential effects that they have on the environment. In the case of Dawson and Foss's lid-removal task, not only did the response topographies differ, but so too did the movement of the lid (sliding vs. twisting). Similarly, in the bidirectional control task, the observed responses resulted in movement of the pole toward one side wall in the case of a left push and toward a different side wall in the case of a right push (but see Heyes, Dawson, & Nokes, 1992, Experiment 2, in which the pole was moved and rotated 90° between observation and performance).

The purpose of the present experiment was to expose pigeons to one of two different response topographies that produced identical effects on the environment. To say that two responses produce identical effects on the environment means that if it were possible to make a similar manipulation of the environment in the absence of the demonstrator, it would not be possible to distinguish between those responses. Specifically, each observer was exposed to a demonstrator that had been trained to either step on a treadle or peck the same treadle for food reward. When observers were given access to the treadle, either response delivered food. The measure of interest was the correlation between the topography of the response of the demonstrator and the topography of the response of the respective observer.

## METHOD

## Subjects

Twenty-eight 5- to 8-year-old White Carneaux pigeons that had been obtained from the Palmetto Pigeon Plant (Sumter, South Carolina) served as subjects. All the pigeons had served in an experiment in which they had been trained to peck at different hues and shapes projected on a lit response key on a vertical surface. The pigeons were individually caged and were

maintained at 80% to 85% of their free-feeding body weights, with free access to water and grit. The colony room was maintained under a 12-hr/12-hr light/dark cycle. The pigeons' care was in accord with institutional guidelines.

## Apparatus

The apparatus consisted of two Large Modular Test Chambers (Coulbourn Instruments, Allentown, Pennsylvania) that each measured 30.5 cm high, 25.5 cm across the response panel, and 28.0 cm from the response panel to the back wall. The side walls (one of which was a door that provided access to the chamber) were made of transparent Plexiglas, and the chambers were positioned so that the side walls opposite the doors of the chambers were virtually touching. The response panel in the demonstrator's chamber included a standard response lever that had been modified to form a 3.8-cm-square treadle mounted horizontally 1.3 cm from the floor. The treadle was located on the demonstrator's response panel 1 cm from the side wall separating the two chambers. A grain feeder was mounted in the center of the demonstrator's response panel. Access to the food, illuminated by the feeder light, was provided through a hole at the bottom of the feeder whenever the feeder tray, mounted outside of the chamber, was raised to the level of the hole. A shielded houselight (28 V, 0.1 A) mounted directly above the feeder (1 cm from the top of the chamber) provided the only other illumination during the experiment. The response panel in the observer's chamber was blank. A schematic representation of the apparatus appears in Figure 1.

## Procedure

Four demonstrator pigeons were magazine trained to eat from the feeder immediately when it was raised. Two of these pigeons were then trained, by successive approximations, to step on the treadle. Each time the treadle was depressed, it provided the pigeon with access to the reinforcer (Purina Pro Grains) for 2 s. The two remaining demonstrators were trained by a similar process to peck the treadle for access to the rein-

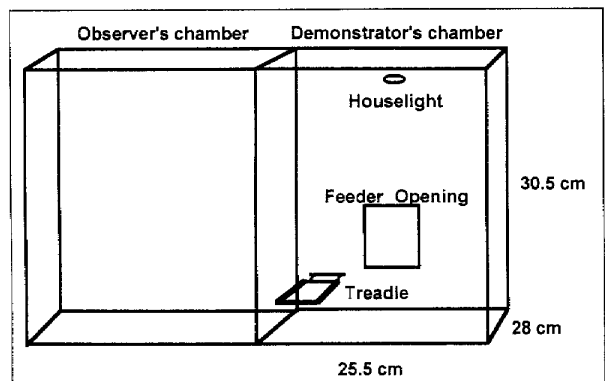


Fig. 1. Schematic representation of the apparatus. See the text for details.

forcer. Training was complete when each demonstrator responded as trained a minimum of 50 times within 30 min (and did not make the alternative response; i.e., pigeons trained to peck did not step on the treadle and pigeons trained to step did not peck the treadle). To ensure that observation would not disrupt the demonstrator's performance, each demonstrator was exposed to a dummy pigeon placed in the observation chamber on 1 or more days prior to exposure to the actual observers.

Each of the remaining 24 pigeons was magazine trained to eat from the feeder and was then exposed to a performing demonstrator for a 15-min observation session. Observers were randomly assigned to the 4 demonstrators. Thus, 6 observers were exposed to each of the demonstrators (12 observers to each response topography). Immediately following the observation session, the demonstrator was removed from the demonstrator's chamber and was replaced by the observer for a single 30-min test session. The number and topography of all responses by each observer were recorded.

## RESULTS

Four of the 24 observers, 2 from each observation condition, failed to respond to the treadle during the 30-min test session and were dropped from the study. All of the remaining 20 pigeons responded reliably to the treadle (a minimum of 50 responses).

Of the 10 pigeons that observed a treadle-stepping demonstrator and later responded to the treadle, 9 stepped on the treadle during the test session and none pecked the treadle. The remaining pigeon in this observation group discovered a few grains of food that had apparently dropped through the grid floor during the observation session. In trying to get to the dropped grains, this pigeon brushed up against the treadle with the side of its head sufficiently hard to operate the microswitch and raise the feeder tray. This pigeon spent the remainder of the session trying to recover the few spilled grains by this means. The data from this pigeon were omitted from analysis. Of the 10 pigeons that observed a treadle-pecking demonstrator, 5 pecked the treadle and 5 stepped on the treadle during the test session.

A Fisher's exact test (Hayes, 1963, p. 599) performed on the data from the 19 observers that either stepped on or pecked the treadle indicated that the topography of responding by the observers was significantly influenced by the topography of the demonstrator's response,  $p = .022$ . In addition to the imitation effect, there was a significant effect of response topography. More pigeons stepped on the treadle (14 pigeons) than pecked the treadle (5 pigeons),  $z = 2.29$ . The pigeons' bias to respond by stepping may have obscured an even stronger imitation effect.

## DISCUSSION

The results of the present experiment indicate that observing pigeons show a significant tendency to copy or imitate the topography of a demonstrator's response. These results were

obtained under conditions that eliminated the possibility of differential social facilitation, local enhancement, and stimulus enhancement (see also similar results in an experiment conducted with Japanese quail; Akins & Zentall, in press).

Some investigators have argued that evidence for imitation cannot consist of behavior that is already in the animal's repertoire (Thorpe, 1963) because such behavior may be an example of contagion (i.e., the unconditioned release of an instinctive behavior). In the present case, however, one would have to posit not only that the demonstrator's treadle pecking is a releaser for pecking the treadle by the observer, but also that stepping on a treadle is a releaser for treadle stepping. More important, one would have to extend the action of the releasers beyond the time of observation, through removal of the demonstrator and transportation of the observer from the observation chamber to the performance chamber (i.e., delayed imitation; Bandura, 1969). Furthermore, how could one ever demonstrate that any behavior an animal is capable of emitting was not already in its repertoire and was simply made more likely to occur in the presence of another animal behaving similarly?

Although the present experiment provides clear evidence of imitative learning in pigeons, the mechanism by which this imitation occurs is not clear. Tomasello (1996) suggests that an observer may understand the intentional relations between the behavior and its resulting outcome (e.g., reward). Thus, he argues that an individual understands that the other is responding in a particular way to obtain food. To test this hypothesis, one can readily ask to what extent the observation of consequences of the behavior is necessary for imitation to occur.

A more basic question concerning the underlying mechanism is, how does an organism know when it is imitating? That is, how does it know when there is a correspondence between the behavior of the demonstrator and its own behavior? According to Piaget (1945/1962), imitation occurs by means of perspective taking. The observer must be able to imagine itself in the place of the demonstrator. Alternatively, Mitchell (1992; see also Heyes, 1993) has proposed that imitation is a product of a learned or innate association between a proprioceptive (felt) stimulus and its visual counterpart. In other words, according to Mitchell, the imitating animal "understands" the relation between the proprioceptive or kinesthetic stimulation provided by its own body and the comparable visual stimulation provided by corresponding parts of the bodies of others. Although there is no evidence to support either account of imitation in animals, neither has a more parsimonious account been proposed.

Whatever the underlying mechanism, data from the present experiment together with those from other experiments suggest that humans are not the only organisms capable of true imitative learning.

Many puzzling questions related to animal imitation remain, however. For example, laboratory attempts to find imitation in apes (chimpanzees and orangutans) and monkeys have often been unsuccessful (Call & Tomasello, 1995; Visalberghi & Fragazy, 1990). Although psychologists tend to think about the cognitive abilities of animals as falling along a scale of evolutionary complexity, with humans, apes, and other primates clustered together at the top, evolutionary pressures may have

## Imitation in Pigeons

resulted in a less orderly distribution of capacity, especially with regard to social learning phenomena.

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