

BRIEF COMMUNICATION

Imitative Learning in Male Japanese Quail (*Coturnix japonica*) Using the Two-Action Method

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The study of imitative learning in animals has suffered from the presence of a number of confounding motivational and attentional factors (e.g., social facilitation and stimulus enhancement). The two-action method avoids these problems by exposing observers to demonstrators performing a response (e.g., operating a treadle) using 1 of 2 distinctive topographies (e.g., by pecking or by stepping). Japanese quail (*Coturnix japonica*) observers exposed to conspecific demonstrators showed a high correlation between the topography of the response they observed and the response they performed. These data provide strong evidence for the existence of true imitative learning in an active, precocious bird under conditions that control for alternative accounts.

The study of social learning (or imitation) in animals has been complicated both by alternative definitions and inconsistent terminology (see, for example, Galef, 1988; Zentall, 1996). Furthermore, several socially influenced, motivational, and perceptual factors have been identified that, although they do not qualify as true imitative learning, could indirectly facilitate the acquisition and performance of an observed response (Thorpe, 1963).

For example, if observation of a response made by a conspecific facilitates the acquisition of that response, relative to a trial-and-error-learning control, it may not be possible to attribute that learning to true imitation because it is possible that response acquisition was influenced by the mere presence of the other animal (i.e., social facilitation, Zajonc, 1965).

Alternatively, if the target response involves a manipulandum, such as a bar-press response, exposing an observer to a bar-pressing demonstrator may merely draw the observer's attention to the location of the moving bar (i.e., local enhancement, Thorpe, 1963). To control for local enhancement, the demonstrator's manipulandum can be separated from that of the observer by the use of duplicate cages (Warden & Jackson, 1935; Zentall & Levine, 1972). In this way the locus of the observed behavior is different from that of the target behavior. However, when the duplicate cages are used, the similarity between the demonstrator's and observer's manipulandum may be sufficient for attention to

generalize from one to the other (i.e., stimulus enhancement, Galef, 1988; Spence, 1937).

One procedure that can control for all of these factors was suggested by Galef, Manzig, and Field (1986, on the basis of an original experiment by Dawson & Foss, 1965). Dawson and Foss found that when budgerigars learned to remove a flat lid from a food cup, they did so in one of three distinctive ways. After conspecifics were exposed to these demonstrators, Dawson and Foss found that each of the observers removed the lid in the same way that they had observed it being done. This procedure has become known as the *two-action method* (Whiten & Ham, 1992). In a variation on this procedure (called the *bidirectional control procedure*, Heyes & Dawson, 1990), demonstrators were explicitly trained to push an overhead pole either to the right or to the left. 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 demonstrator.

Recently, Zentall, Sutton, and Sherburne (in press) noted that the ideal control condition should rule out observed differences in the movement of the manipulandum by the two groups. Any difference in the way the manipulandum moved could serve as a distinctive perceptual cue. For example, Dawson and Foss's (1965) lid-removing demonstrators caused the lid to move differently, relative to the food cup, depending on whether the lid was pushed off, pulled off, or twisted off. Similarly, Heyes and Dawson's (1990) right-pole-pushing demonstrators always pushed their pole toward a particular wall of the chamber and that location could have served as a distinctive cue.

Zentall et al. (in press) trained demonstrator pigeons to operate a treadle for food reinforcement with one of two distinctive response topographies (pecking or stepping). After exposing conspecifics to performing demonstrators, the observers were permitted to respond to the treadle for food, using either topography. A significant correlation was found between the observer's performance and the behavior that they observed. Although the results reported by Zentall et

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al. show clear evidence of imitative learning, some of their observers failed to make any responses; whereas almost 25% of their observers' response topographies were different from what they observed. Perhaps better evidence for imitation would be found by using the two-action method developed by Zentall et al. if members of a more precocious species, one that might be more sensitive to social cues (Klopfer, 1962), were used.

Precocial birds, such as ducklings, often develop attachment behaviors by observing their parents (Lorenz, 1937) or their siblings (Klopfer, 1959). Japanese quail chicks (*Coturnix japonica*) are also highly precocial. They display approach and avoidance behaviors (Schaller & Emlen, 1962), early preferences for visual stimulation (Kovach, 1974), and imprinting behavior (e.g., Eiserer & Swope, 1980). A recent investigation by Beulig and Dalezman (1992) found that quail chicks (24-hr posthatch) demonstrated stronger imprinting to a stimulus after they had observed an already imprinted chick following a stimulus.

Although some research on social learning with quail has been reported (Sanavio & Savardi, 1980), the procedure involved the observation of a demonstrator pecking a lit response key. As noted earlier, this procedure allows for an account of the findings in terms of local or stimulus enhancement.

The purpose of the present experiment was to investigate true imitative behavior in adult male quail by using the two response topographies that Zentall et al. (in press) used. Observer quail were given visual access to a demonstrator that was either stepping on or pecking at a treadle for food reinforcement. The observers were then given access to the treadle, and the correlation of response topography between observers and their respective demonstrator was examined.

Method

Subjects

Twelve male Japanese quail, approximately 10 months old and maintained in accordance with institutional guidelines at the University of Kentucky, served as subjects (4 as demonstrators and 8 as observers). The quail were housed in individual wire mesh cages (GQF Manufacturing Co., Savannah, GA) and were maintained on a 23-hr food deprivation schedule, with water available continuously. All birds had previously served as subjects in a Pavlovian contextual conditioning experiment in which they were provided sexual opportunity with a female quail in a large test arena. The colony room was maintained under a 16-hr/8-hr light-dark cycle.

Apparatus

A schematic diagram of the apparatus used in the present experiment appears in Figure 1. The same apparatus was used to test imitation in pigeons (see Zentall et al., in press). The apparatus consisted of two Large Modular Test Chambers (Coulbourn Instruments, Lehigh Valley, PA). Each test chamber was 30.5 cm high, 25.5 cm wide, and 28.0 cm deep. The demonstrator's chamber consisted of a treadle, a rectangular feeder opening, and a houselight. The treadle measured 3.8 cm square and was mounted

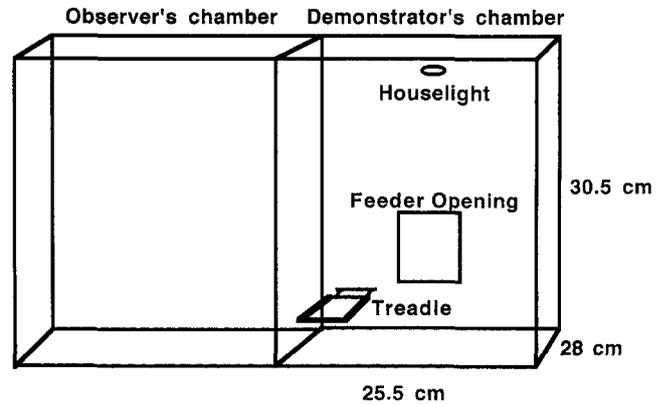


Figure 1. A schematic diagram of the apparatus used in the present experiment.

horizontally along the back wall, approximately 1.3 cm from the floor. It was located 1 cm from the side wall that separated the two test chambers and was to the left of the feeder opening. The feeder opening (5.72 × 5.08 cm) was located in the center of the demonstrator's chamber. Subjects were provided access to food (Southern States 40% Poultry Supplement) through the opening whenever the feeder tray was raised and illuminated by a feeder light. A shielded houselight (28 V, 0.1 A) mounted above the feeder opening, near the ceiling of the chamber, provided illumination of the demonstrator's chamber for the duration of the experiment. A speaker, also located near the ceiling of the demonstrator's chamber, provided white noise at about 72 dB.

The two side walls of the demonstrator's chamber were made of transparent Plexiglas. One side wall was a door that provided access to the chamber. The other side wall served as the wall between the demonstrator's chamber and the observer's chamber. There was no treadle, feeder, or houselight in the observer's chamber.

Procedure

Two birds each were randomly assigned to serve as either pecking demonstrators or stepping demonstrators. They were magazine trained to eat from the feeder tray when it was raised. After magazine training, they were trained to peck or step on the treadle by a shaping (by successive approximations) procedure. During the last few days of training (before testing), the demonstrators were exposed to a "dummy" bird in the observer's chamber to ensure that the presence of an observer would not disrupt the demonstrator's performance.

Each of the eight observers was magazine trained in the demonstrator's chamber and was given 4–5 days of habituation in the observer's chamber (with no demonstrator present). Observers were randomly assigned to one of the four demonstrators.

During a test session, an observer was placed in the observer's chamber for a 10-min observation period while a demonstrator pecked the treadle or stepped on the treadle at a rate no slower than one response per 10 s. (None of the demonstrators responded slower than this criterion.) Immediately after the observation session, the demonstrator was removed and the observer was placed into the demonstrator's chamber for a 30-min opportunity-to-respond period. The frequency and topography of all observer responses were continuously recorded. Treadle responses were recorded automatically by means of a microswitch attached to the

treadle. The two response topographies were easily distinguished by the experimenter because the posture of the quail when it pecked the treadle (head down, body away from the treadle) was quite different from its posture when it stepped on the treadle (head up, body over the treadle). Thus, there was no overlap in the response topographies.

Results

For each observer, the topography of the first treadle response was always the same as the topography of the response that had been observed (i.e., in every case, if it had observed pecking, the observer's first response was a peck; if it had observed stepping, the observer's first response was a step). The binomial probability of such a correspondence between demonstrator and observer response topography occurring by chance is very small, $p = .004$.

Data for each subject, from the first 5 min of the 30-min session, plotted as the proportion of total responses that were pecks, are presented in Figure 2. For all analyses performed, the .05 level of statistical significance was adopted. A one-way analysis of variance (ANOVA) performed on these data indicated that subjects that observed a pecking demonstrator made a significantly higher proportion of their responses by pecking than did subjects that observed a stepping demonstrator, $F(1, 6) = 103.67$. The mean proportion of pecks for the two groups was 0.93 and 0.21, respectively.

The mean frequency of pecks and steps that were displayed by the group that observed pecking and by the group that observed stepping, for the first 5 min of the 30-min session, is presented in Figure 3. A two-way ANOVA performed on the observers responses, with group and response produced as variables, revealed a significant main effect of response, $F(1, 6) = 10.49$, indicating that the overall mean frequency of pecking ($M = 37.50$) was greater than that of stepping ($M = 15.25$). There was also a significant Response \times Group interaction, $F(1, 6) = 34.75$. The interaction indicated that the frequency of treadle-response topography made by the observers was correlated with that made by their respective demonstrator. There was no significant main effect of group, $F(1, 6) = 5.24$.

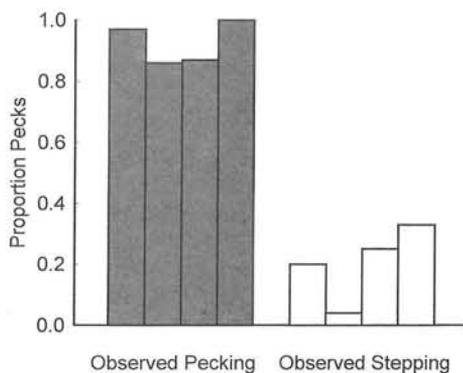


Figure 2. For each subject, the proportion of total responses that were pecks during the first 5 min of the 30-min session.

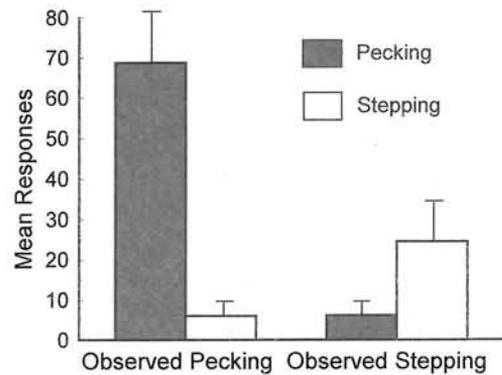


Figure 3. The mean (± 1 SEM) frequency of pecks and steps that were made by quail that observed pecking and by those that observed stepping for the first 5 min of the 30-min session.

To better identify the source of the Response \times Group interaction, we performed separate one-way repeated-measures ANOVAs on the observers' responses from each observation group. Although, with only four subjects per group, the power of these tests was very low, for the observers that observed pecking, significantly more treadle pecks were made than treadle steps, $F(1, 3) = 31.07$. For the observers that observed stepping, however, the greater number of steps than pecks did not reach statistical significance, $F(1, 3) = 5.13$.

A three-way ANOVA was then performed on the response-frequency data from the entire 30-min session to examine the pattern of responding over time (in 5-min bins). The ANOVA indicated that pecking and stepping responses decreased as a function of time, as evident by a significant effect of time, $F(5, 30) = 3.26$. At the end of the experiment, the demonstrators were given a 30-min test session in the absence of an observer. The demonstrators showed a decrease in response rate over the course of the 30-min session that was similar to that shown by observers (over 80% of the demonstrators' responses occurred within the first 10 min of the session). Thus, the overall decrease in response rate over time appeared to result from satiation rather than from the decrease in social facilitation resulting from the increase in time because the observer had been in the presence of the demonstrator. Little evidence of a decline in response rate was found over the first 10 min of these sessions. Thus, it is not likely that demonstrators' rate of responding declined over the 10-min observation session.

A significant Time \times Group interaction was also found, $F(5, 30) = 2.61$, which appeared to result from the higher original level of responding shown by quail that observed a pecking demonstrator than by those that observed a stepping demonstrator (see Figure 3). Further, this decline in pecking for the group that observed pecking was also greater than the decline in pecking displayed by the group that observed stepping. Finally, there was a significant three-way interaction, $F(5, 30) = 6.11$, which apparently resulted from the high level of pecking by quail that observed a pecking demonstrator.

Discussion

The present findings provide clear evidence for true imitative behavior in male Japanese quail. Male quail that were provided visual access to a pecking demonstrator pecked more than they stepped when they were given the opportunity, and those that were provided visual access to a stepping demonstrator stepped more than they pecked.

This imitation effect cannot be accounted for by stimulus enhancement because a two-action method that provided two different response topographies should have had similar stimulus enhancing effects. More important, the observer's response to the treadle matched the response topography of its respective demonstrator. Thus, the response topographies displayed by the observers were not random responses resulting from attention being drawn to the treadle.

Although quail subjects appeared to imitate stepping as well as they imitated pecking, the frequency of imitated pecking was greater than the frequency of imitated stepping. This difference in responding may have been due to differences in the ease of making the two responses (i.e., it may have been easier for quail to peck the treadle than to step on it). Alternatively, the quail may have been more "prepared" to peck in this context than to step. The notion of preparedness proposed by Seligman (1970) is that organisms are more or less prepared by evolution to form associations between various conditioned stimuli and unconditioned stimuli. Perhaps quail are more likely to peck than to step in the context of food reinforcement.

The present results with quail replicate and extend the findings of Zentall et al. (in press) with pigeons. Although each pigeon generally responded with a single response topography (either pecking or stepping, but not both), all of the quail responded with both topographies. This finding may have resulted from the fact that the quail were generally more active than the pigeons. Furthermore, the correlation between demonstrator and observer response topography was much better than that for pigeons. For the pigeons, only 19 of the 24 observers either pecked or stepped on the treadle following observation, and of those 19, only 14 made the same response as their respective demonstrator. For the quail, however, a substantially higher proportion of every quail's responses matched the response topography of its respective demonstrator. Furthermore, it appears that one can find these strong imitation effects with as few as 4 quail per group.

The present results also support recent findings by Heyes, Dawson, and Nokes (1992) that rats can copy the relative direction of an observed pole push, even when the direction of the push required of the observer is orthogonal to that of the pole push that they observed.

We originally hypothesized that the precocial quail might be more sensitive to social cues and thus may be better able to show evidence of social learning than the more altricial pigeon. If this is true, it also might be appropriate to examine imitation in young quail. Furthermore, it would be interesting to know if young quail can learn through imitation as well when the demonstrator is another young quail

(perhaps a clutch mate, horizontal transmission) as when it is an adult quail (perhaps a parent, vertical transmission).

It is also possible that differences in general activity level between the two species may play a role in the differences found in imitative learning. To distinguish between these two variables, one might test an altricial species that is more active than pigeons or a precocial species that resembles the pigeons in its general level of activity.

In evaluating whether a copied response qualifies as imitation, Thorpe (1963) has argued that one should consider only motor acts that are not already in the repertoire of the animal. He proposed this requirement to preclude the possibility that species-typical behavior, such as eating and mobbing, that may be socially elicited (or mediated) but is probably not socially learned, might be interpreted as imitation. Strictly speaking, it could be argued that the pecking and stepping responses that were observed and performed in the present research were not novel behaviors. On the other hand, in some sense, it is not clear what response the quail would be capable of making that was not already in their repertoire. Surely, these quail had never pecked at or stepped on a treadle before. In this sense, these were novel responses. Furthermore, to explain the present findings in terms other than imitation, one would have to posit not only that pecking by a quail elicited pecking by an observing quail and that stepping by a quail elicited stepping by an observing quail but also that these elicited responses would be directed toward the demonstrator's treadle (rather than simply occurring in the observer's chamber). More important, however, these elicited responses would have to be deferred to a time when the observer was placed in the demonstrator's chamber and the demonstrator was no longer present. Thus, what may appear to be parsimonious in terms of mechanism may turn out to be quite complex and improbable in practice.

The function of imitation for the genetic fitness of an animal is reasonably clear. As Boyd and Richerson (1988) have proposed, imitative learning can fill an important gap between an animal's relatively inflexible, genetically predisposed behavior and its highly flexible, individually learned behavior. Imitation has some of the flexible characteristics of individual learning, yet it does not require experiencing the often long-delayed and perhaps even lethal consequences of trial-and-error learning.

The mechanism by which imitation works is less clear. The motivation to reproduce the response of a conspecific may be genetically based. However, the ability of an animal to reproduce that response requires that the animal match the proprioceptive and kinesthetic feedback from its own behavior to the visual stimulation from the behavior of the demonstrator (Heyes, 1993; Mitchell, 1992). The human imitation literature is not very helpful in this regard. According to Piaget (1945), for example, imitation occurs by means of perspective taking on the part of the observer. The observer must be able to imagine itself in the place of the demonstrator. Not only is it unlikely that most animals (with perhaps the exception of higher primates, Gallup, 1970) have the ability to take the perspective of a conspecific, but very young children, below the age at which they demon-

strate any ability to take the perspective of another, appear to show some evidence of imitation (Meltzoff, 1988). Thus, the mechanism responsible for imitation in animals remains somewhat of a mystery.

The present results suggest, however, that Japanese quail are an excellent species with which to study imitative learning in animals and that the two-action method is an appropriate procedure to use to help answer some of these theoretical questions.

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