SOCIAL LEARNING BY FOLLOWING: AN ANALYSIS¹

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Learning by "following", probably a common means by which behaviors are socially transmitted from adults to young in many species, was analyzed. Pigeons first learned to eat from a human hand. When the hand then approached an operant key and pecked it, the pigeons followed and quickly learned to do the same, thereby demonstrating social learning. When the hand only led the birds to the area of the key, without demonstrating the key-peck response, the birds learned as rapidly as with a key-peck demonstration. Birds also learned, but less reliably and more slowly, when they could observe the hand's responses but were constrained and unable to follow. "Following" was also shown to engender very rapid learning of a more complex, two-member response chain.

Key words: imitation, response matching, social transmission, autoshaping, key peck, pigeons

Social learning—where one animal acquires a new response more readily because of an interaction with another animal—is found in many species (Davis, 1973; Hall, 1963). However, experimental analyses of animal social learning are scarce and incomplete, especially when compared with analyses of human social learning (Bandura, 1971). The present series of experiments attempted to analyze social learning mechanisms that are operative in the common leader-follower relationship. Young animals often follow their parents or elders and learn to behave as their elders (Davis, 1973). Although generally attributed to imitation, the significant causes of learning through following are not well understood. To study such learning, Neuringer and Neuringer (1974) trained young pigeons to follow an experimenter's hand around a large operant chamber. The hand occasionally provided food for the pigeon, analogous to how parent pigeons provide food to young squabs by regurgitating grain (Wortis, 1969). After the birds had learned to follow, the hand ap-

proached a small disk and struck it to produce grain in a food hopper. These birds learned to peck the disk significantly sooner than birds trained by reinforcement of successive approximations to the peck response; thus, the efficacy of social learning was demonstrated. However, Neuringer and Neuringer did not identify how such learning occurred. In particular, they did not determine whether imitation necessarily plays a role when one animal learns by "following" the responses of another animal.

In the present research, an attempt was first made to replicate the Neuringer and Neuringer findings. Since the pigeon could *follow* the hand to the key, *observe* as the hand pecked the key, and then *eat* from the operated hopper, the replication condition will be called Fol-Obs-Eat. Social learning in that condition was analyzed by presenting each of the three components separately. In the Fol-only condition, the pigeon could only follow the hand to the key. The hand never pecked the key, grain was never presented in the hopper, and therefore the birds neither observed key-peck demonstrations nor ate grain. In the Obs-only condition, birds were confined behind a wire-mesh screen and thus could only observe as the hand pecked the key and then pecked at grain in the operated hopper. These birds could neither follow the hand nor eat grain. In the Eat-only condition, the hopper was operated intermittently, giving the birds access to grain. Here, the hand did not enter

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the chamber, and thus birds could neither follow the hand nor observe peck demonstrations.

Three hypotheses were tested in Experiment I. The first was that social learning occurred only when the birds could observe the hand peck at the key and grain. This hypothesis predicts that birds in the Fol-Obs-Eat and Obs-only groups should learn the response, perhaps equally fast; those in the Fol-only and Eat-only groups should not learn. Second, the birds may have learned to peck only because they were led by hand to the area of the key, resulting thereby in an increased probability of contact with the key, or an increased "operant level". According to this hypothesis, birds in the Fol-Obs-Eat and Fol-only groups should learn about equally fast, and those in the Obs-only and Eat-only groups should not learn. The third hypothesis was that social learning was caused by multiple factors, that both observing and following played important roles, and that the effects of the two were additive. Were this true, birds in the Fol-Obs-Eat group would peck soonest, birds in the Eat-only group would take the longest time before pecking, or not peck at all, and the remaining two groups would fall between these extremes.

EXPERIMENT I

METHOD

Subjects

Thirty-nine experimentally naive White King pigeons, eight to 14 weeks old at the beginning of training, were housed individually and maintained at 85% of their free-feeding weights. Grit and water were continuously available in the home cubicles.

Apparatus

An insulated wooden chamber, 76 by 51 by 36 cm, served for this and the subsequent experiments. A 31- by 11-cm access opening was cut into the base of one of the 76-cm sides, permitting the experimenter's hand to move freely within the chamber. Mounted above this access opening was a wide-angle lens, permitting observation of the chamber. One 51-cm wall contained a Gerbrands response disk and a hopper in which mixed grain could be presented. The response disk was 8 cm above the hopper, was similar in color to the sur-

rounding metal panel, and was never transilluminated. One overhead 7-W bulb provided continuous white light. A wire-mesh screen, 51 by 36 cm, could be moved into a position parallel to, and 35 cm from, the key-panel wall (see Figure 1). Standard relay programming and recording equipment was located in an adjoining room. The sound of the chamber's ventilation fan provided masking noise.

Procedure

All squabs received the same preliminary training. In Session 1, the squabs ate from a blue plastic cup, 3.8 by 3.8 cm, placed on the floor of the chamber. Grain was scattered on the floor around the cup. In Sessions 2 to 6, squabs could approach and eat from the experimenter's hand, which held the blue cup just inside the access opening. Grain was scattered on the floor around the hand-held cup at the start of the second session only. Sessions 1 to 6 ended when the bird approached the cup (latencies ranging from seconds to over an hour) and ate the amount of grain needed to maintain its 85% weight.

In Sessions 7 to 13 (12 min each), birds had to follow the experimenter's hand to obtain intermittent feedings. As this follow-the-feeder training progressed, the experimenter required following for longer distances and times before allowing access to the cup. Also, each access became longer. Thus, during the first training session, most birds fed 20 to 30 times for an average of 5 sec per access, after short periods of following. By the last session, most birds received seven to nine longer feedings, and were required to follow continuously for as long as 3 min before being fed. The experimenter attempted to ensure that feeding occurred equally often in all areas of the chamber. Sessions occurred at least every other day and not more often than once per day.

Before the last training session, squabs were ranked from best to worst follower according to how much time they spent close to the hand, and four groups were formed with equal average ranks. Groups were randomly assigned to treatment conditions. Birds assigned to the Obs-only condition were exposed to the wire-mesh screen for 5 min before the final training session. During Session 14 (first experimental session), all birds received one hopper-training trial: the hopper was operated after a bird had begun to feed on the few pieces of

grain placed before the hopper opening. The hopper was not lowered until the bird ate continuously from it for 15 sec. Overhead illumination never changed when the hopper was raised.

The four treatments were:

(1) In the demonstration phase of the Fol-Obs-Eat condition, the experimenter's hand approached the key area, "pecked" the dark key with the index finger after distributing several pecks near the key, then approached and pecked at grain made accessible for 6 sec in the hopper. The squab was unconstrained and therefore could follow the hand, approach and peck the key, and similarly approach and obtain grain from the hopper. The hand always permitted the bird access to key and hopper. One "peck" demonstration by the hand occurred aperiodically during each 30 sec; the hand remained stationary in the rear of the chamber between demonstrations. After 10 demonstrations, the hand was removed from the chamber and the squab's behavior was observed during a 10-min test period. In this test phase, which followed the demonstration phase of all four conditions, no changes occurred unless the bird pecked the key and thereby produced 6 sec of access to grain. The main question was whether and when the birds would peck when alone in the chamber.

(2) In the demonstration phase of the Fol-only condition, the hand moved to the key areas and remained next to the key for several seconds of each 30-sec period, but the experimenter never pecked the key and hopper grain was not provided. Ten such "demonstrations" were followed by the 10-min test period.

(3) In the demonstration phase of the Obs-only condition, each squab was confined behind the wire-mesh screen during all demonstrations (see Figure 1). Though they could observe the full demonstration available to Fol-Obs-Eat birds, they could neither follow the hand nor eat grain during demonstrations. After 10 demonstrations, the constraining screen was removed before the usual test phase.

(4) In the Eat-only condition, the hand never entered the chamber. During the demonstration phase, hopper grain was presented to unconstrained birds 10 times independently of the squab's behavior, on the average of once every 30 sec. The usual test phase followed.

To ensure following, birds in the Fol-Obs-Eat, Fol-only, and Obs-only groups began each

experimental session with 15 sec of feeding from the hand. Birds were not fed from the hand during the remainder of each session. The main datum was the time elapsed before the first peck to the key in the absence of the hand, *i.e.*, during the test period. Time to the first peck was used so as not to confound the effects of the reinforcement contingencies with the social contribution to learning. Because the Obs-only birds were confined during the demonstration phase, time to peck during the test phase was used, thereby permitting direct comparisons among groups.

RESULTS

Table 1 shows total elapsed test-period times before the first recorded key peck for each bird. For the purposes of statistical analysis, birds that never pecked were assigned the scores they would have received had they pecked at the start of the thirteenth test pe-

Fig. 1. Two views of the chamber used in the three experiments. H indicates the hopper opening; A and B mark the boundaries of the access opening through which the hand entered the chamber; K1 through K5 indicate response keys: S1 and S2 indicate screens to constrain a bird to one side of the chamber; L1 and L2 indicate overhead signal lights. K1 and S1 were used in Experiment I. S1 and S2 were used in Experiment II, and K2 was the operative key. K5 and K2 were operative keys in Experiment III and L1 and L2 served as signal lights.

Table 1
Time (min) Elapsed in Test Period before a Response

Subjects	Conditions			
	Fol-Obs-Eat	Fol-Only	Obs-Only	Eat-Only
1	8.00	10.35	120.00	120.00
2	15.00	8.25	120.00	48.25
3	54.45	1.25	72.50	16.87
4	22.43	16.25	6.83	12.37
5	7.83	69.52	39.50	120.00
6	31.33	2.50	6.08	.08
7	11.92	58.25	64.43	7.25
8	10.00	94.40	67.97	.73
9	10.50	5.22	53.00	120.00
10	—	28.45	120.00	53.72
$\bar{X} =$	19.05	29.44	67.03	49.93
$s =$	15.35	32.92	43.14	51.62

riod. Cochran's C-test (Winer, 1962) showed that variances were homogeneous ($C = 0.46$, $p < 0.01$). Analysis of variance showed a significant effect of treatments ($F[3, 35] = 2.94$, $p < 0.05$). Although the Fol-Obs-Eat birds responded sooner than did the Eat-only control birds—an average of 19 min *versus* 50 min—contrary to expectations the two groups did not differ significantly ($t[17] = 1.72$, $p > 0.05$). The Fol-Obs-Eat condition was statistically superior to the Obs-only condition ($t[17] = 3.15$, $p < 0.01$, two-tailed), but not significantly different from the Fol-only condition. The Fol-only condition proved to be significantly superior to the Obs-only condition ($t[18] = 2.19$, $p < 0.05$, two-tailed), an unanticipated result. Another unanticipated result was the ordering of the Obs-only and Eat-only conditions, which did not differ significantly.

DISCUSSION

The Fol-only birds never saw the key-peck response demonstrated, nor did they receive grain in the hopper during demonstration periods. But they learned approximately as fast as the Fol-Obs-Eat birds. Furthermore, the Fol-only birds learned significantly faster than both Obs-only birds and Eat-only control birds. There are thus two negative conclusions: first, the Fol-only birds did not learn to peck because of response matching or imitation. Second, key pecking was not caused by an energizing effect of the grain reinforcer (*cf.* Herrnstein and Loveland, 1972).

When following the hand, Fol-only birds were brought close to the key. Given the pre-

disposition of pigeons for exploratory pecking, it might be thought that being led to the area of the key would alone be sufficient to produce pecking. But, in fact, most birds first pecked during the test phase, when no guidance was available. Therefore, some form of conditioning to approach the key area must have occurred. The Fol-only birds, as well as Fol-Obs-Eat birds, may have learned to peck because they were conditioned to approach an area previously inhabited by the model; the birds thereby came close to an object, the key, capable of evoking peck responses which, for the Fol-Obs-Eat birds, were incidentally similar to those displayed by the model.

A similar analysis may help to explain the unexpectedly rapid acquisition by birds in the Eat-only condition and the fact that they did not differ significantly from the Fol-Obs-Eat birds. Although no model was present, when the Eat-only birds approached the operated hopper, their proximity to the key may have increased the probability of adventitious key contact.

The Obs-only condition, in which constrained birds could only observe demonstrations, led to poorer performance than the Eat-only control. Thus, it appears that merely observing a model's behavior was insufficient to engender learning in the present case. But the comparison between the Obs-only and Eat-only groups may be misleading because of the incidental conditioned-approach discussed above. Eat-only birds were led to the area of the key by the occasional operations of the hopper during demonstration periods, whereas

the Obs-only birds were confined and never reinforced for approaching the hopper or key. Therefore, the comparison between Obs-only and Eat-only birds leaves unanswered the question of whether the Obs-only group learned anything from passive exposure to key-peck demonstrations and consequent grain deliveries.

EXPERIMENT II

To answer that question, and to determine whether the Fol-Obs-Eat procedure leads to significantly more rapid acquisition than the Eat-only procedure, response key and food hopper must not be in close proximity. In Experiment II, key and hopper were separated. Additional response keys were added to determine the extent to which following a hand to a specific key, or observing it near the key, influenced pecking to that key in particular. Also, an additional condition, Obs-Eat, was added to test whether the learning to peck in Experiment I may partly have been caused by a correlation between hand at key and the bird then receiving grain in the hopper. Such a correlation is similar to that under autoshaping contingencies, where illumination of a key precedes grain reinforcement (Hearst and Jenkins, 1974). The hand-at-key in Experiment I may have served the same function as key illumination in the autoshaping situation.

METHOD

Subjects

Twenty-nine experimentally naive White King pigeons, all less than 12 weeks old at the start of training, were maintained as in Experiment I.

Apparatus

The several changes made in the chamber can be seen in Figure 1. Keys at K2, K3, and K4 were added. Keys 1, 2, 3, and 4 were located 8, 56, 76, and 38 cm, respectively, from the hopper opening. In this experiment, the key at K2 was programmed to function as had the key at K1 during Experiment I: now, any peck to key 2 produced 6 sec of grain in the hopper. Pecks to the other keys had no scheduled consequences, but were counted. Screens made of wire mesh were placed at S2 and S1 during the demonstration periods of conditions Obs-only and Obs-Eat, respectively.

Procedure

Sessions 1 to 12 were the same for all birds, and as in Experiment I. Session 13, the seventh follow-the-feeder training session, was omitted. After Session 12, birds were randomly assigned to the five groups. The thirteenth session was devoted exclusively to training the birds to eat from the hopper. Ten hopper presentations were given, the first lasting 15 sec, the remainder lasting until the bird ate for 6 sec.

Each squab was then exposed to one of five conditions. The procedures in the first four were identical to those in Experiment I, except that the hand now approached K2, and only pecks to it, by hand or squab, produced grain in the hopper. The fifth condition, Obs-Eat, was similar to the Fol-Obs-Eat, except that birds were not permitted to follow and approach the key during demonstrations. They did have access to the hopper. The presence of screen S1 accomplished this restriction. Thus, each time the hand pecked the key, the squab could eat from the hopper.

RESULTS AND DISCUSSION

Table 2 shows individual test-period times before the first peck to key 2. For the purposes of statistical analysis, birds that never pecked were assigned the scores they would receive had they pecked at the start of a forty-first test period. Cochran's test showed homogeneous variances ($C = 0.46$, $p < 0.01$). Analysis of variance showed a significant effect of treatments ($F[4, 24] = 3.93$, $p < 0.025$). Birds in the Fol-Obs-Eat group acquired the key-peck response significantly faster than the birds in the Eat-only group ($t[9] = 3.25$, $p < 0.005$, one-tailed). Because of the separation of response key from grain hopper, absolute times to acquisition in this experiment were considerably longer than in Experiment I. Presumably for the same reason, the difference in acquisition rate between the two groups was more pronounced and now statistically significant. Thus, our predictions concerning the effects of separating hopper and key were confirmed.

As in Experiment I, the Fol-only birds acquired the key peck significantly more rapidly than the Eat-only birds ($t[9] = 3.40$, $p < 0.005$, one-tailed) and, again, there was no difference between Fol-Obs-Eat and Fol-only performances. Merely leading the pigeon to the key

Table 2
Time (min) Elapsed in Test Period before a Response

Subjects	Conditions				
	Fol-Obs-Eat	Fol-Only	Obs-Only	Obs-Eat	Eat-Only
1	12.17	145.08	180.12	400.00	299.43
2	31.17	66.28	87.85	7.12	262.00
3	22.50	20.40	89.68	59.88	400.00
4	182.68	14.12	8.38	133.58	400.00
5	76.00	76.00	185.40	400.00	29.72
6	20.73	7.33	67.37	106.70	—
$\bar{X}$ =	57.54	54.87	103.13	184.55	278.23
s =	65.33	52.58	68.36	172.35	151.76

sufficed to engender pecking: neither demonstration by the hand of a particular response topography nor presentation of grain was necessary for this social learning.

As in Experiment I, birds in the Obs-only condition took considerably longer to acquire the key peck than birds in both Fol-Obs-Eat and Fol-only groups, although in the present case the differences were not significant ($t[10] = 1.18$ and $t[10] = 1.37$, respectively). However, unlike Experiment I, the predicted difference between Obs-only and Eat-only groups was found ($t[9] = 2.55$, $p < 0.025$, one-tailed) again due, presumably, to the fact that Eat-only performances were not enhanced by a close proximity between operandum and reinforcement dispenser. That proximity of key to hopper did, indeed, increase the probability of a key peck was shown by responses emitted to each of the three ineffective keys in the chamber before the session in which an effective peck to K2 was made. Taking all birds together, there was an average of five responses per bird made to K1 (8 cm from the hopper), three responses to K4 (38 cm from the hopper), and 0.6 responses to K3 (76 cm from the hopper) before the first response to the effective key, K2 (56 cm from the hopper). There were no significant differences between groups in the number of pecks to the ineffective keys, but birds in the Eat-only condition emitted more responses to K1 (an average of nine per bird), the key directly above the hopper, than birds in any other group.

The principal departure from prediction was the poor performance of the Obs-Eat group. Because of results from the autoshaping literature (*cf.* Hearst and Jenkins, 1974), especially those of Moore (1973), we expected birds in this group to acquire the key peck

rapidly. They did not, however, and their performance did not differ significantly from that of Eat-only birds. Though the Obs-Eat procedure was introduced to assess the contribution of systematic pairing of the finger-at-key stimulus with grain deliveries, observation of the birds' actual behaviors under this condition indicated that they tended to orient away from the hand, and toward the hopper, as soon as the hand began moving toward the key and before demonstration pecks occurred. In most instances, therefore, they did not see the hand peck the disk.

EXPERIMENT III

Experiment III asked whether a more complex response could be transmitted using the follow-the-feeder training procedure.

METHOD

Subjects

Fourteen birds, all of which learned to peck a key in Experiment I, were allowed to feed freely until they established a new 100% body weight. They were then deprived and maintained at 80% of this new weight for the duration of the experiment.

Apparatus

Another key was installed at the point labelled K5, 35 cm from the hopper opening (Figure 1). Keys at K2, K3, and K4 were removed. K5 and K1 were never transilluminated and resembled in color the surrounding metal panel. Also, a red Christmas-tree bulb was mounted at point L2, on the ceiling above the hopper area. The white bulb at L1 and key at K1, both used in Experiment 1, were also used.

Procedure

All birds were given two additional days of follow-the-feeder training before the experimental phase began. Birds were randomly assigned to the two conditions, a Fol-Obs-Eat condition, and an Eat-only condition, both analogous to those previously described. However, here, a chain of two responses was required for reinforcement. When the white light, L1, was illuminated, a peck to K5, the distal key, caused the white light to go dark and the red light, L2, to be illuminated. A peck to K1 in the presence of the red light resulted in 6 sec of grain reinforcement and a return to the "white" condition. In the Fol-Obs-Eat condition, the hand appropriately pecked K5, on the average of once every 30 sec, in the presence of the white light, and then moved slowly to K1 and pecked it in the presence of the red. As in the above experiments, birds could follow the hand, peck at keys, and eat grain whenever accessible. In the Eat-only condition, the hand was absent from the chamber during the demonstrations, which consisted of stimulus changes and hopper presentations according to the same temporal pattern as for the Fol-Obs-Eat condition, but occurring independently of the birds' behaviors. In both conditions, 10 demonstration trials were followed by a 10-min test period.

RESULTS AND DISCUSSION

Times to completion of the first chain are reported in Table 3. Because variances were not equal ($F[6/6] = 86.50$, $p > 0.05$), Cochran's conservative t -test was employed (Snedecor and Cochran, 1967). The predicted difference of faster learning by the Fol-Obs-Eat birds was significant ($t[6] = 2.30$, $p < 0.05$, one-

tailed). Note also the extremely rapid acquisition of the response chain by the Fol-Obs-Eat birds when compared with a similar condition in Experiments I and II. The birds in the present experiment had already learned to peck a key and the appropriate chaining of this response was greatly facilitated by the hand's demonstration.

GENERAL DISCUSSION

Researchers sometimes conclude that an instance in which one animal behaves like another is an instance of response matching, or imitation (e.g., Zentall and Levine, 1972). The term "imitation learning" has had widely varied usage (Davis, 1973) but is used here specifically as follows. When one animal observes (usually visually) a model emit a particular topography of response, one never before emitted by the observing animal, and the latter comes to emit this same response because of the specific observation, the new response is said to be acquired by imitation. Imitation learning implies (a) a matching of observer's response topography to the model's, and (b) that the *particular* topography serve a critical function. As indicated by the present experiment and elsewhere (Galef, 1971), imitation is not necessarily involved when one animal comes to behave in the same manner as the model. Other factors may lead to matched responding, and three of these are discussed below.

Stimulus Selection

Among social species, one animal often follows another. Young follow their mothers to gain access to beak or breast, fish school together, imprinted ducklings follow, and so forth. The "following" animal may be brought into a specific stimulus environment in which a response is possible. Concerning most conditioning experiments, it is not trivial to note that the subject's behavior is significantly constrained when it is placed in the experimental chamber. Furthermore, conditioners often induce approach to reinforcement dispenser and operandum by scattering food nearby. Analogously, in many instances in natural environments, the only uniquely social contribution to behavior transmission may be that, without being led to a certain environment, a learner would never encounter the situation

Table 3

Time (min) elapsed in test period before completion of a complete response chain.

Subjects	Fol-Obs-Eat	Eat-Only
1	1.62	70.00
2	8.62	12.25
3	6.42	8.75
4	3.00	17.80
5	0.82	70.00
6	1.17	15.27
7	0.88	4.40
$\bar{X} =$	3.22	28.35
$s =$	3.09	28.78

and its peculiar contingencies. If the learner is well prepared for the response to be "transmitted", *i.e.*, if the particular response has a high probability of emission, this extremely simple social guidance will be very effective. The present case involved such a high-probability response, the pigeon's peck. (Future research must determine whether there can be learning-through-following of topographically improbable responses.) Pigeons are likely to peck at objects in their environment. When the hand went to the key and stopped there—never demonstrating the key-peck response—birds in Experiments I and II learned to peck as rapidly as with a key-peck demonstration. It would appear, therefore, that situation selection was sufficient for social learning of the key peck. Some form of conditioning must also have been involved, however, since most of the birds responded first in the absence of the hand, during test periods. Just as the birds were first conditioned to approach a hand that fed them, they were later conditioned to approach a place, the area of the key, that was correlated with the hand's presence.

Stimulus Enhancement

A model may manipulate the environment in such a way as to make a particular stimulus more readily observable, or bring the attention of an observer to the stimulus (see Thorpe, 1963). For example, the model may break the hull of a shell, enabling sight of the contents to engender behavior in the observer. Or an observer may be caused to observe those specific aspects of the environment with which the model interacts. Enhancing a stimulus may increase the probability of an observer responding to that stimulus, if only because of stimulus summation. This is particularly so when the stimulus is a "releaser" for a given response, or when a response is otherwise highly prepared (*cf.* Ewer, 1969, on tuition among animals).

It is difficult to separate the enhancement factor from others that lead to social learning. Thus, in the present research, stimulus enhancement was possibly functioning in all groups where the hand approached the key. However, since birds in the Obs-only and Obs-Eat groups did not acquire the key peck nearly as rapidly as those in the Fol-only and Fol-Obs-Eat groups, it is unlikely that stimulus enhancement played as great a role as other fac-

tors in Experiments I and II. Enhancement may have contributed significantly to group differences in Experiment III, where demonstrations may have served to "point out" the distal key.

Stimulus Value Transformation

Models can transform the value of stimuli. If, for example, followers observe nonrandom patterns in which reinforcers are correlated with neutral stimuli, the latter may acquire reinforcing properties themselves. In the Fol-Obs-Eat, Obs-only, and Obs-Eat groups, especially, the potential for such transformation existed: the hand pecked the key causing food, a primary reinforcer, or, for the Obs-only birds, sight of food, a conditioned reinforcer. Thus, in each case there was a pairing between "hand pecking key" and primary or conditioned reinforcement. Furthermore, since the hand itself was previously established as a conditioned reinforcer when it fed the birds, second-order conditioning was possible. For the Fol-only birds, as well as those in the above three groups, the hand was differentially paired with the area of the key, and that area might thereby have been transformed into a reinforcing place. This transformation would explain why birds in the Fol-only group approached and pecked the key in the absence of the hand.

It is possible that following the hand increased the probability that the contingency between key and hand was actually observed by a bird. The following task required close tracking of the hand's behavior, thereby increasing the probability of exposure to the contingency. Thus, responding by an observer that facilitates exposure to a nominally available contingency may be important for social learning (*cf.* Bindra, 1972, 1974; Olson, 1970). Absence of such responding may help explain the poor performance of the Obs-Eat group: birds tended to orient toward the hopper before the hand reached the key area, thereby decreasing exposure to the crucial contingency. Similarly, birds in the Obs-only groups did not have the following task to facilitate attention to demonstrations.

Many different mechanisms—*e.g.*, stimulus selection, stimulus enhancement, stimulus value transformation, and imitation—may concurrently serve to ensure that one animal comes to behave as its conspecifics. The pres-

ent research shows that imitation (the most commonly invoked "explanation" of social learning) was not necessary for the social transmission of the key-peck response. Though clear cases of imitation have been demonstrated in humans (e.g., children imitated multi-syllable neologisms in Bandura, Ross, and Ross, 1963), the authors count only one probable case in the experimental literature on social learning in animals (Dawson and Foss, 1965). In the few studies where sufficient controls have been devised, no convincing evidence for an active response-matching process has been forthcoming. For example, a series of 13 experiments by Galef and associates (Galef, 1971; Galef and Clark, 1971) on the transmission of acquired poison avoidance in rats showed that imitation was not functional in that social situation. Since social learning is not all of one kind, analytical paradigms are required for its study.

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