Observational learning in the pigeon: Effects of model's rate of response and percentage of reinforcement

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Seventeen pigeons observed a model peck an illuminated key at either a high or a low rate and obtain a high or low percentage of possible reinforcement. Observers were subsequently placed on an automaintenance schedule. Although there was no difference among groups in the number of trials to the first peck, when the present data were compared with other researchers' automaintenance-acquisition data, there was some indication that modeling reduced the number of trials to the first peck over nonmodeled birds. However, by the end of 20 sessions, the birds that had observed a model pecking at a high rate and with consistent reinforcement pecked significantly faster than those that had observed the model peck at a slow rate or obtain infrequent reinforcement. The conclusion is that two types of information are transferred via a model: first, a correlation between the stimulus and the reinforcer, and second, the specific or minute attributes of the schedule that may produce reinforcement.

Davis (1973) has pointed out that, in much of the modeling literature, the dependent variable has been either the matching of response topography (see, e.g., Dawson & Foss, 1965) or the acquisition of a response in fewer trials than controls (see Bullock & Neuringer, 1977; Corson, 1967; Del Russo, 1971; Gardner & Engel, 1971; Kohn, 1976; Zentall & Hogan, 1976). The basic questions posed have thus been "what is learned?" and "how fast is it learned?"

An additional question may also be asked as to what it is in the modeling situation that aids the observer in acquiring the appropriate response. In this situation, the emphasis is placed on how or what attributes of the model's performance effect the subsequent responding of the observers. In much research, this question has been left untouched. Most modeling research either assumes or assures consistent behavior on the part of the model (Corson, 1967; Groesbeck & Duerfeldt, 1971; Kohn, 1976; Neuringer & Neuringer, 1974) and efforts are taken to assure the similarity of model performance. For example, Kohn (1976) used overtrained rats as models in a discrimination task and Church (1957) required that

model rats reach the goal section of a T-maze within 2 sec after reaching the starting gate. If the model was to perform at anything less than optimal performance, efforts were taken to assure that it didn't perform at all so that the observing organism saw either a model not performing or a naive model (Sanavio & Savardi, 1980) or a model that either pecked or ate, but not both (Zentall & Hogan, 1976). Variations of the actual performance to be modeled were not tested.

In natural environments, parents or other adults serve as models. Reports have been written about young animals' learning to feed by imitation of their parents (Wortis, 1969) and about the lack of learning when the young were blind (Levi, 1977). In a similar situation involving audition rather than vision, chaffinches develop normal song in their 2nd year only if allowed to hear normal adult song before their 1st autumn; without exposure to normal song, it does not develop. In one study (Thorpe, 1961), the young birds were reared together but without adults. An elaborate, but atypical, song developed. However, within that particular group, the song was similar (see, also, Davis, 1973; Hinde, 1969; Marler, 1970; Nottebohm, 1970). It would seem that these birds served as their own models.

It appears, then, that the quality of the observers' behavior may depend on the model's performance. If the model's behavior is effective, then the observers' behavior may also be effective. It is also possible that an increase in the intensity or consistency of a model's performance may produce overall improvement in observer performance, whereas less intense model performance may result in mediocre or even nonexistent matched behavior.

In the present study, the attempt is made to demonstrate the effects of the intensity of the model's performance by

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having a model peck at a key at either a fast or a slow rate. Observers were subsequently given the opportunity to peck. It was hypothesized that those that observed the model pecking at high rate would not only acquire the pecking response in fewer trials, but would also maintain a higher rate of pecking for a given period of time.

METHOD

Subjects

Seventeen experimentally naive male White Carneaux pigeons served as observers. An additional, experienced male White Carneaux pigeon served as the model. All animals were maintained at 80% of their free-feeding weights and had access to water and grit in the home cages.

Apparatus

A three-key pigeon chamber measuring $49 \times 33 \times 51$ cm was used. The keys (3 cm in diameter) were placed horizontally along the front panel 4.8 cm from each other and 26 cm above the floor. The side keys were located 8.25 cm from the side walls and remained inoperative throughout the experiment. The aperture for the grain hopper (Lehigh Valley) was 5 cm square located 11.5 cm below the center key and 9.5 cm above the floor. A white 7-W houselight was situated 4 cm above the center key and was continually lit during experimental sessions.

A clear Plexiglas panel divided the chamber in a near-diagonal fashion. It extended from the back right corner to a point on the left wall 12 cm from the front panel. It thus divided the chamber into a performance space (adjacent to the keys and hopper) and an observation space. A ventilation fan operated continuously and provided masking noise.

Programming of session events and recording of data were performed by a Digital Equipment Corporation PDP-8/e computer using the SuperSKED software system.

Procedure

All observers were hopper trained and randomly divided into two groups: Group F observed the model pecking at a high rate (approximately 186 pecks/min) and Group S observed the model pecking at a substantially slower rate (approximately 36 pecks/min). The model was trained in sessions that consisted of 50 trials marked by a 10-sec keylight presentation and separated by a variable 30-sec intertrial interval (ITI). A 4-sec access to mixed grain followed keylight presentations, provided that response rate requirements were met. For the fast condition, a differential reinforcement of high rate (DRH) schedule was in effect: 25 or more pecks per trial were required for reinforcement. For the slow condition, 9 or fewer pecks were required per trial, although at least 1 peck had to occur; that is, a differential reinforcement of low rate (DRL) schedule was in effect.

Following the model's training, the observation sessions were begun. In these, the model was placed in the performance space and the hopper-trained observer was placed in the observation space. After 15 min of no stimulus presentation, the trials began. Immediately following the termination of the 50-trial session, both birds were returned to their home cages. Forty-five minutes later, the observer was placed in the performance space of the chamber and a positive automaintenance schedule (10-sec keylight, 4-sec hopper, variable 30-sec ITI) was presented for 50 trials. In this procedure, the hopper is presented automatically following the fixed period of keylight illumination. This same automaintenance schedule was in operation for each bird on each subsequent day until a total of 20 automaintenance sessions had been completed. Thus, each bird received one modeling session followed by 20 automaintenance sessions.

Since only one model was used and the key was transilluminated with white light in both the fast and slow conditions, each group was split into two segments for modeling purposes. The model was first trained under the fast condition, and half of the birds designated for that group were modeled. Then the model was retrained under the slow condition, and half of the "slow" birds were modeled. The model was again retrained to peck under the fast condition, and the same cycle was then repeated for the remaining half of the birds.

RESULTS

The performances of the birds were initially similar regardless of the manner in which the model had performed. Both the number of pecks and the number of trials to the first peck were statistically insignificant.

Medians and means for trials to the first peck were 2.0 and 8.3 for Group F and 3.5 and 23.9 for Group S, with an overall median and mean of 2.3 and 15.0 for both groups combined.

As illustrated in Figure 1, an interaction between the two groups was observed over days [$F(19,285) = 5.79$, $p < .00001$]. Although no significant differences between groups (day-by-day analysis) were observed until Day 8,

Figure 1. Mean number of pecks per session for Groups F and S. The vertical bars represent the standard errors.

after that point between-group significance hovered around $p < .02$ for the remainder of the days (see Table 1 for actual values).

Closer examination of the data revealed an interesting ordering of observer behavior, one which seemed to correspond to the actual performance of the model. When the model had performed well (i.e., obtained greater than 65%-70% of reinforcement during the modeling session), the subsequent observer performance tended to occur at a much higher rate than when the model's performance produced sparse reinforcement. Since this phenomenon seemed so consistent (overlap occurred within parent groups in only one case), a further division for analysis was instituted as follows: the birds that observed the model pecking at a fast rate and with greater than 65%, or good, reinforcement (FG) and less than 65%, or poor, reinforcement (FP) attainment and the corresponding slow groups observing good (SG) and poor (SP) attainment of reinforcement. These data are summarized in Figure 2. The numbers of birds in each group were 5, 4, 6, and 2 for Groups FG, FP, SG, and SP, respectively.

Again, the initial performances of all birds were similar. However, differences emerged by Session 4 with

Figure 2. Mean number of pecks per session for Groups FG, FP, SG, and SP. The vertical bars represent the standard errors.

Table 1
F Values and Probability Levels for the Differences Between Means for Groups F and S for Each Day Postmodeling

Day	F	df	p
1	0.17	1,15	0.6840
2	0.10	1,15	0.7599
3	0.05	1,15	0.8332
4	1.79	1,15	0.2013
5	2.42	1,15	0.1408
6	4.06	1,15	0.0622
7	3.73	1,15	0.0727
8	6.32	1,15	0.0238
9	8.00	1,15	0.0127
10	7.50	1,15	0.0152
11	7.27	1,15	0.0166
12	7.07	1,15	0.0179
13	7.08	1,15	0.0178
14	6.86	1,15	0.0193
15	6.53	1,15	0.0220
16	7.71	1,15	0.0141
17	11.36	1,15	0.0042
18	11.57	1,15	0.0040
19	6.69	1,15	0.0206
20	8.27	1,15	0.0116

those that had observed "good" modeling performing at a higher rate than those that had observed "poor" modeling [$F(3,13) = 5.12, p < .05$, Newman-Keuls]. Beyond that point, the distance between Group FG and the other groups further widened such that by the end of 20 sessions a difference of around 800 pecks per session was exhibited [$F(2,12) = 17.36, p < .001$, Newman-Keuls]. The mean number of pecks per trial for Session 20 was 22.08, 6.34, 5.68, and < 1 for Groups FG, FP, SG, and SP, respectively. Additionally, beyond Session 4, no statistical differences were seen among the other three groups, with birds from Groups FP and SG being essentially indistinguishable. Birds in Group SP responded for the first few sessions and then essentially stopped responding; during the last 10 sessions, the number of pecks per session ranged from 0 to 31, with the mean being 6.6.

DISCUSSION

In the present study, the hypothesis that observers exposed to a model that pecked at a high rate would acquire the pecking response in fewer trials than those that observed slower rates of pecking was not confirmed; there was essentially no difference in acquisition rates among the groups.

Since the current study did not include conditions in which an alternate group of observers confronted an empty chamber or an empty chamber in which keylight-hopper pairings were presented, a strong statement regarding enhanced acquisition through observation as opposed to a no-model condition is inadvisable. However, the prompt emission of keypecks by birds in all of the present groups (mean of 15 trials to the first peck) may be contrasted with the results from Brown and Jenkins's (1968) classic study of autoshaping. Using a trials procedure similar to that of the present study, but with a longer ITI (VI 60 sec),

those authors found a mean of 45 trials before the first keypeck occurred. However, the provision in the current study of 50 observational trials prior to direct access to the response key complicates a direct contrast, as does Brown and Jenkins's use of a longer ITI. An interesting aspect, nevertheless, is that longer ITIs decrease the number of trials needed for the acquisition of autoshaping (Gibbon & Balsam, 1981; Jenkins, Barnes, & Barrera, 1981). Given temporal spacing alone, Brown and Jenkins's birds should have acquired keypecking in fewer trials than those in the present study; but they did not. The major variable, then, appears to be the presence of a pecking model and/or the prior observation of key-light/hopper pairings. Procedural dissimilarities also complicate a direct comparison with Zentall and Hogan's (1976) finding of a median of 10 trials to the first keypeck for 14 pigeons exposed to a trials procedure in which the model pecked on an FI 9-sec schedule during the trial. Although these complications with comparison do exist, indications are that the rate of acquisition of pecking per se seems to be accelerated for modeled birds. Bullock and Neuringer (1977) and Thorpe (1963) suggest that a model may aid in making a particular stimulus more observable or aid in bringing the attention of the observer to the stimulus (stimulus enhancement hypothesis). A demonstration of the behavior may aid in enhancing the stimulus and thus increase the rapidity of the acquisition of the behavior, but the fine mechanics of a model's performance may be of little importance for increasing the rate of acquisition of an easily learned response.

Nevertheless, the major interest of the present study was not the rapidity of keypeck acquisition so much as the influence of the model's rate of responding on the subsequent response rates emitted by the observers. Here the results seem quite decisive. After a few hundred trials, the mean number of pecks emitted per trial by birds who observed the model both pecking the key at a high rate and obtaining a high degree of reinforcement was clearly greater than that for subjects who observed the model pecking at a low rate and/or with poor reinforcer attainment. The divergence among the groups grew more extreme with additional sessions.

It is possible that the information conveyed by the model was different in each group. In all cases, there were some nonreinforced trials in each of the modeling sessions, with the poor groups having a high percentage of nonreinforced trials. For birds that watched the fast model, the nonreinforced trials were due to too little pecking, whereas for birds in the slower groups, there generally was too much pecking. Once the observers had become accustomed to the experimental situation and had acquired the task (about Session 3), the more qualitative aspects of the model's effect became apparent. To birds that watched the fast model obtain reinforcement, the information might have been to peck extremely fast to obtain reinforcement. This would be indicated by the continual acceleration in pecking and a mean rate above that exhibited by automaintained birds without models in other studies. Typical rates

have been cited as 6–15 pecks per trial with a 6-sec key-light (Schwartz & Gamzu, 1977; Schwartz & Williams, 1972b). The birds that observed the fast model not obtain reinforcement and the birds in the slow groups may have received different messages. The informational message may have been similar to that produced by negative automaintenance (Herrnstein & Loveland, 1972; Schwartz, 1972, 1973; Schwartz & Gamzu, 1977; Schwartz & Williams, 1972a; Williams & Williams, 1969), resulting in lessened response rates. Even though the observer was reinforced for every trial in which it pecked, the strength of the stimulus-reinforcer relationship could have been weakened by model trials that did not terminate with reinforcement. Aversive properties may have been transferred to the key. Wasserman and his colleagues (Wasserman, 1981; Wasserman, Franklin, & Hearst, 1974) demonstrated that pigeons would approach but not peck an illuminated key after negative correlation even when the key was later positively correlated with food delivery. Inasmuch as pecking did occur, a total negative correlation did not occur; however, negative aspects may have been related to the key and have been present.

On the other hand, a more effective, less wasteful method of obtaining food may have been exhibited. An increased expenditure of energy would not produce more reinforcers; therefore, it would be more beneficial to respond at a lower rate. This conjecture, however, needs more research.

A curious phenomenon is that the birds in Group SP acquired pecking much as did the birds in the other groups with respect to rate and number of trials, but then stopped within four or five sessions. The autoshaping contingency would seem to have been overshadowed by a prior memory of both slow and ineffective pecks on the part of the model. Perhaps the birds could tolerate either slow pecks or ineffective pecks and still exhibit a moderate rate of pecking, but could not tolerate both conditions. It is unclear why this complete overshadowing would take place unless the aversive properties were somehow made stronger by being combined, which, when coupled with the peculiarities of an automaintained procedure in which pecks early in a keylight illumination were temporally removed from reinforcement, resulted in a cessation of responding.

It must be stated, however, that the further division of the groups into the good and poor categories was a post hoc division; therefore, more research must be completed to confirm the phenomenon.

Again, it is noted that the birds in both the fast and slow conditions that observed the model obtain a high proportion of reinforcers subsequently maintained pecking at a greater rate than those that had observed poor attainment of reinforcers. As can be implied from the work of other researchers, a model doing anything other than the desired task or behaving poorly may do more harm in establishing a specific task, be it acquisition or more prolonged performance, than no prior related experience with the

task. John and his colleagues (John, Chesler, Bartlett, & Victor, 1968) demonstrated a failure in cats to acquire a leverpress task when the model did nothing more than move to a food receptacle and eat from it following onset of stimulus presentation. (Perhaps the observer really did match the behavior of the model quite well by learning that the lever was of no consequence in obtaining food.) Rats performed similarly when previous observation was to a naive (nonconsuming) demonstrator rather than to a consumatory demonstrator or an empty box (Zentall & Levine, 1972), again indicating a decreased acquisition of response following observation of a model performing responses inappropriate to the desired behavior.

In summary, the present experiment has illustrated several effects of modeling in pigeons. First, observation of a conspecific speeds acquisition of keypecking, and second, following acquisition, rates in responding vary dependent upon the rate and effectiveness or appropriateness of the model in performing the task. Two types of information were possibly transferred to the observer: first, a correlation between the key and hopper (acquisition), and second, the specific manner or schedule with which access to grain might be obtained (rate of responding). Like the earlier work of Zentall and Hogan (1976) and Bullock and Neuringer (1977), the present results support the efficacy of observation as a means of learning. Moreover, with Millard (1979) and Millard, Deutsch-Klein, & Glendon (1981), they suggest that specific aspects of a conspecific's behavior may exercise discriminative control over the behavior of an observer, and that such control may extend over a temporal distance.

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