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LEARNING OF A RESPONSE-REINFORCER CONTINGENCY BY OBSERVER PIGEONS[1]

APRENDIZAJE DE UNA CONTINGENCIA RESPUESTA-REFORZADOR EN PALOMAS OBSERVADORAS

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ABSTRACT

The data of three experiments on observational learning are reported. Experiment 1 assessed the effects of modeling different contingencies between pecking a peg and food reinforcement, on acquisition of the same response in observer pigeons. Results show that the group of pigeons exposed to demonstrations of the response – reinforcement contingency showed a faster rate of acquisition than the group exposed to demonstrations of random response – reinforcement contingency, or than the groups that saw a model eat without pecking the peg, or than the group simply exposed to the model. Experiment 1B varied the number of trials with food and the number of trials with an opening response in a two random groups but failed to find similar acquisition levels. Experiment 2 was designed to evaluate, in the experimental situation used in experiment 1, the rate of acquisition of two different responses (pecking and pulling) by the observers, when only one of those responses had been shown instrumental in producing food reinforcement.

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Results showed that the observers learned both types of responses, but in testing they emitted the response demonstrated by the model in the previous stage. These data supports the argument that a response-reinforcement contingency is necessary for observational learning, and that pigeons may learn a response-reinforcer contingency rather than a stimulus-stimulus association.

Key words: observational learning, imitation, response-reinforcer contingency, pigeons

RESUMEN

Se presentan los resultados de tres experimentos sobre aprendizaje observacional en palomas. El experimento 1 evaluó los efectos de diferentes demostraciones de contingencias entre picar una madera y reforzamiento con alimento en palomas observadoras. Los resultados mostraron que el grupo de palomas expuesto a demostraciones de la contingencia picar – reforzamiento adquirió las respuestas mas rápidamente que el grupo que fue expuesto a demostraciones aleatorias entre picar – reforzamiento, que el grupo que vio al modelo consumir el reforzador sin haber emitido la respuesta de picar, o que el grupo que fue expuesto al modelo sin que respondiera o fuera reforzado. El experimento 1B varió el numero de ensayos con reforzamiento y el numero de ensayos con una respuesta en dos grupos aleatorios pero no se observaron niveles comparables de aprendizaje. El experimento 2 fue diseñado para evaluar la tasa de adquisición de dos respuestas diferentes (picar y jalar) por observadores que habían visto que solamente una de ellas producía el reforzamiento. Los resultados indicaron que los observadores adquirieron ambas respuestas, pero en la prueba emitieron la respuesta que vieron asociada con reforzamiento durante la fase de demostración. Estos datos apoyan la argumentación de que el aprendizaje por observación involucra el aprendizaje de asociaciones respuesta-reforzamiento más que estímulo-respuesta.

Palabras clave: aprendizaje por observación, imitación, contingencia respuesta-reforzador, palomas

Several laboratory studies have shown that whenever animals observe a trained model performing a response, and this response is followed by a reinforcer, the observers acquire similar responses faster than subjects who have not observed the trained model. This phenomenon known as imitation or observational learning (OL) has been reported in a wide variety of animal species, in diverse situations, both experimental and natural, and using a variety of responses and tasks (see reviews by Lefebvre & Palameta, 1987; Nieto, Cabrera, Guerra & Posadas-Andrews, 1987; Heyes & Galef, 1996).

Earlier studies emphasized form similarity between the modeled response and the copied response as the most important characteristic of this phenomenon; thus, response shape or topography was key evidence that imitation had occurred. More recently however, greater emphasis has been placed in analyzing the conditions promoting OL, the associative elements involved in OL, and its similarities with other sorts of associative learning (Zentall, 1996; Domjan, Cusato, & Villarreal, 2000; Nieto y Cabrera, 2003). The experiments reported in this study contribute to show which conditions are necessary for OL in pigeons; in particular, the effects of systematically varying the response-consequence relationship were evaluated.

Two earlier studies have manipulated the characteristics of the modeled contingency and have assessed the effects of that experience on the acquisition of the response. Sherry & Galef (1984) carried out a two-stage experiment; they first exposed a group of naive observer chickadees to a model trained piercing paper seals covering containers with food (the imitation group); a second, or stimulus enhancement, group was exposed to already perforated containers; the third group of birds was exposed to containers with non-perforated paper seals. Then all groups were given an acquisition test with the baited and sealed containers. Sherry & Galef (1984) reported that the observers in both the imitation and the stimulus enhancement groups acquired the piercing response of piercing equally well, whereas no observer in the third group did so. Thus, demonstrating a response-reinforcer relation does not seems necessary for observational learning.

Palameta & Lefebvre (1985) compared acquisition of a piercing response in pigeons; observers in the Observational learning group were exposed to a model trained to pierce open a paper sheet that covered a box containing 10 g of mixed grain, to three control groups; observers in the No model group were never exposed to the model; observers in the Blind imitation group saw the model pierce the paper cover, but not eat, since there was no food in the model's box; observers in the Local enhancement group saw a model eat from a 6 cm hole, and thus never saw the model piercing the paper cover. Palameta & Lefebvre reported that all pigeons in the OL group and four out of five pigeons in the local enhancement group pierced the paper and ate the food; neither the blind imitation nor the no model group produced the required response. A second experiment using a two-stage procedure in which demonstration occurred first and then testing was conducted in the absence of the model, showed that only the OL group emitted the paper piercing response but not the local enhancement group. Therefore a response – reinforcer contingency demonstration seems necessary for observational learning to occur at least in pigeons.

The purpose of these experiments is to provide further and perhaps more precise information regarding the role of the response-reinforcer relation in the acquisition of new responses by observation.

Experiment 1

As already mentioned, data reported by Sherry & Galef (1984) and by Palameta & Lefebvre (1985) are contradictory regarding the role of the demonstration of the response - reinforcer relationship in the acquisition of new responses in two bird species, chickadees and pigeons, respectively. These studies differ in several aspects (i.e., species, apparatus and procedures) any of which could be responsible for the different results. Therefore, it is necessary to explicitly vary different values of the response - reinforcer relation during the modeling phase; furthermore, showing that OL occurs when observers are exposed to a response – reinforcer relation also requires showing that OL does not occur when observers are exposed to a random relation between responding and reinforcement. This logic has been used in other conditioning preparations to demonstrate the need of the stimulus-stimulus contingency, or response-stimulus, for learning to take place (Miller & Escobar, 2002; Rescorla, 1967; Rescorla & Wagner, 1972). Thus, the objective of this experiment was to assess the effect of demonstrations of different response – reinforcer contingencies on the acquisition of that response by groups of observer pigeons.

METHOD

Subjects

Forty adult pigeons with no prior experimental experience were used; they were obtained from a commercial dealer and were kept in individual cages. Their average initial weight was 335 g (range 280 to 390 g); they were kept at 80% of their initial weights throughout the experiment. One additional bird was trained as the model.

Apparatus

Two wire mesh cages were used; each cage measured 25 cm long, 15 cm wide and 23 cm high. It was covered with black cardboard except for the front wall. This wall had an opening measuring 7 x 7 cm, and at 8 cm from the floor, through which the pigeon could reach outside the cage. The cages were placed facing each other, separated by a tray measuring 30 x 30 cm. There were two stands with clips; each clip could hold an inverted gray tube facing the front wall of each cage. The tubes could be closed with a rubber stopper to which a wooden peg measuring 3 x 1 cm was glued. The tubes could be baited with 30 millet seeds, when the tube was pecked open the seeds could fall on the tray and be eaten by the pigeon.

Procedure

Each observer was placed in the testing cage for 10 min, for five consecutive days prior to modeling. The experiment consisted of two successive phases.

Modeling phase

Observer birds were randomly assigned to each of four groups (n=10). All observers were exposed to 12 modeling trials; each trial lasted 60 s and the inter-trial interval was 45 s in average (range 15 to 75 s). The model bird was trained over a long number of sessions and conditions to make sure that it would consistently peck during modeling sessions. The experiment was conducted in two identical replications.

Observers in the Positive group saw a model pecking the tube open, and always receiving reinforcement. Observers in the Random group saw the model experience four sorts of trials: a) Pecking the tube open was reinforced on three trials; b) on three additional trials pecking the tube open was not reinforced; c) on other three trials the model was exposed to the tube but reinforcement was manually presented; d) on a further three trials the tube was presented but without the peg and food. These trials were presented in a mixed order. Observers in the Food-only group saw the model being reinforced at the start of the trial, but no response was required. Finally, observers in Model-alone group saw the model that was never exposed to the tube nor to food reinforcement.

Testing phase

This was conducted immediately after the last modeling trial. The model was removed, and the observers were individually exposed for the first time to the baited tube; pecking the tube open was reinforced on all 12 testing trials. Trials ended with a reinforced peck or if 60 s had elapsed without a peck; inter-trial interval was 45 s in average (range 15 to 75 s).

Recording and data analysis

All trials were videotaped and two experimenters recorded the number of trials with a successful peck. Data were analyzed by analysis of variance and *post hoc* Newman-Keuls tests.

Results and Discussion

Results showed that the number of observers in the Positive group that learned to open the tube during the test session was higher than any of the other three groups. Eight birds in the Positive group learned to open the tube; whereas only four birds in the Random group and two birds in the Food-only groups learned to open the tube. Birds in the Model-only group did never open a tube in a single trial and were omitted from subsequent analyses.

Figure 1 shows the mean percentage of trials with a successful response for each group during the test session. Observers in the Positive group responded successfully in more than 50% of the trials, whereas the Random and Food-only groups did so in 20%, and 10% of trials, respectively. As mentioned earlier the Model-only group did not respond during the test session and was therefore omitted from subsequent statistical analyses. Analysis of variance showed that groups were significantly different, $F(2, 29) = 19.75$, $p < .05$; a *post hoc* Newman-Keuls test revealed that the Positive group differed significantly from the two other groups which did not differ among themselves.

Figure 2 shows the mean number of trials for each group to open a tube for the first time. It is clear that the Positive group started to open tubes significantly earlier than any of the other groups. Statistical analysis showed that the groups were significantly different, $F(2, 29) = 13.09$, $p < .05$; a post-hoc Newman-Keuls showed that the Positive group was significantly different from the other two groups, which did not differ among themselves.

These results show that exposing a pigeon to pecking a peg followed by reinforcement, during a modeling phase, facilitates learning that response in a subsequent test session. Subjects in the groups exposed to the response-reinforcer contingency not only started to peck earlier in the test, but they also pecked in a higher number of trials than any of the other groups. Nevertheless, it should be noticed that subjects in the Random group were intended to receive the same response – reinforcer demonstrations as the Positive group, except that the response always preceded reinforcement in the latter group. The procedure however, failed to equalize the number of trials with food with the number of trials with an opening response between the Positive and Random groups. That is, in the Random group only six trials over 12 comprised food, as opposed to 12 over 12 en the Positive group, and only six trials over 12 comprised an opening response. If there was a facilitatory effect of food presentation, or pecking, in addition to the effect of pairing pecking with food, a difference between these groups may be expected.

Experiment 1B

The aim of this experiment was to compare acquisition of pecking response by two groups of pigeons exposed to the random procedure used in Experi-

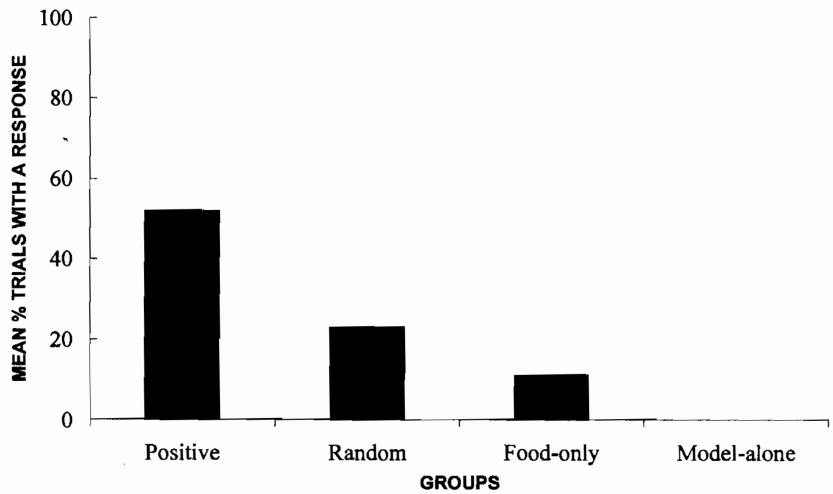

Figure 1. Mean percentage of trials with a successful response for each group during the test session in Experiment 1.

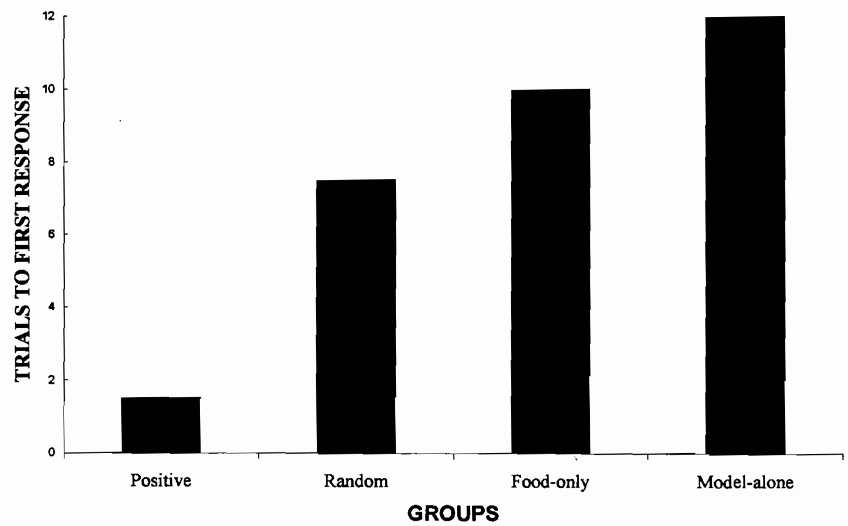

Figure 2. Mean number of trials for each group to open a tube for the first time in Experiment 1.

ment 1, but the number of trials for one of the groups was increased to 24 with the aim of equalizing the number of exposures to the opening response and to food with the Positive group in experiment 1.

METHOD

Subjects and Apparatus. The bird used as model in the previous experiments was used. Additionally, 20 naïve birds were used as observers, their mean weight was 330(range 290 to 403 g). They were obtained and kept as described in experiment 1. The apparatus used was the same as in experiment 1.

Procedure. The procedure was the same as in experiment 1.During the modeling phase observer birds were randomly assigned to two groups (n=10 each). All observers were exposed to modeling trials; each trial lasted 60 s and the inter-trial interval was 45 s in average (range 15 to 75 s).

Observers in the 12 trial random group saw the model experience four sorts of trials: a) Pecking the tube open was reinforced on three trials; b) on three additional trials pecking the tube open was not reinforced; c) on other three trials the model was exposed to the tube but reinforcement was manually presented; d) on a further three trials the tube was presented but without the peg and food. Observers in the 24 trial random group experienced the same four sorts of trials except that they were exposed to six trials of each sort. Trials were presented in a mixed order for both groups. The testing session was conducted immediately after demonstration ended, they was conducted as in experiment 1.

Results and Discussion

The number of birds that opened a tube during the test was four and six for the 12 trial and 24 trial random groups respectively. As in the previous experiment, the number of trials with a successful peck was low for both random groups; observers in the 12 trial group opened the tube in 26% of the test trials, whereas the 24 group opened a tube in 36% of the trials. Statistical analysis reveled that groups did not differ significantly in the percentage of trials with a successful peck (Mann-Whitney U test= 0.314, p>.05). Thus, the results of this experiment indicate that the facilitatory effect of modeling a response-reinforcer relation found in experiment 1, could not be attributed solely to the unequal number of trials with food or to the number of trials with an opening response, because the 24 trial group received 12 trials with reinforcement and 12 trials with an opening response, the same number of trials asthe positive group in experiment 1, but performed not better than the 12 trial random group. Thus, equalizing the number of food reinforcement and response openings in a random group to the number response and reinforcement trials received by the positive group in experiment 1, suggests that this variable does not seem to be the crucial for the effect found in the Positive group.

Our results strongly suggest that a demonstration of a forward relationship between pecking and reinforcement promotes OL.

Experiment 2

Although these results show the importance of the response-reinforcement contingency in OL, it is not clear that the birds did learn the response - reinforcer relation. The observers did not learn a new response, pecking was an already learned response for all the birds. It is therefore possible that demonstrations by a feeding pigeon had only redirected pecking to the peg. Thorpe (1963) has referred to this effect as local enhancement, implying that the model's behavior attracts the observer's attention to an environment feature, which in turns induces the appropriate response. A similar effect has been reported in autoshaping procedures with pigeons (Brown & Jenkins, 1968), where pecking responses elicited by the keylight - reinforcer contingency redirects consummatory pecking towards the key.

Heyes and coworkers (Heyes & Dawson, 1990; Heyes, Dawson & Nokes, 1994) have addressed the question of whether observers learn a stimulus-stimulus or a response-reinforcement association using the "bidirectional procedure". In this procedure, demonstrator rats were trained to push a joystick towards the right or left on a fixed ratio schedule of food reinforcement. During the demonstration stage, one group of observers saw that pushing right was reinforced; another group of rats saw that pushing left was reinforced. During the acquisition test session, observers rats moved the joystick in the same direction the demonstrator had show them in the previous stage. Heyes & Dawson (1990) have also showed that learning is retarded if observer rats are required to learn the opposite response to that demonstrated in the previous stage.

Zentall, Sutton & Sherburne (1994) have also addressed this question using a "two-response procedure". They trained pigeons to press or to peck a pedal for food. Observers were exposed to a model performing either of the two responses. They reported that observers showed a clear tendency to perform the response that was demonstrated by the model during the previous stage (see also Akins & Zentall, 1996). Akins and Zentall (1996) exposed a group of observers to a model performing an action (pecking a pedal) and another group was exposed to a model performing a different action (pressing a pedal) with the same operandum. In the test, observers were exposed to the operandum in the absence of a model. These authors reported that observer pigeons executed the same action they had seen the model perform (see also Zentall, Sutton & Sherburne, 1998). It seems fair to conclude that the observer's attention is not only being directed to a feature of the environment, rather responding is affected by the sort of response the demonstrator used to procure reinforcement; that is, by the response - reinforcement contingency demonstrated earlier in training.

The next experiment may be seen as an extension of these designs using a different experimental procedure. Particularly, experiment 2 was designed to evaluate, in the experimental situation used in experiment 1, the rate of acquisition of two different responses (pecking and pulling) by the observers, when only one of those responses had been shown instrumental in producing food reinforcement.

METHOD

Subjects

Twenty four adult pigeons obtained and kept as those in experiment 1 were used. Their mean initial weight was 309 g (range 289 to 330 g); they were kept at 80% of their initial weights throughout the experiment. Two additional pigeons were trained to pull a ring or to peck at a wooden peg.

Apparatus

The same apparatus used in experiment 1 served in the present experiment, except that a 2 cm ring with a 1 cm chain was attached to a rubber stopper; in this case the inverted tube was raised so that the ring was at about 8 cm from the floor.

Procedure

Each observer was placed in the testing cages for 10 min, for five consecutive days prior to modeling. The experiment properly consisted of two phases and was run in two identical replications.

Modeling phase

Observer birds were randomly assigned to each of three groups (n=8). All observers were exposed to 20 modeling trials; each trial lasted 60 s, and the inter-trial interval was 45 in average (range 15 to 75 s). Observers could be exposed to either a model pecking the wooden peg or to a model pulling a ring during this phase; reinforcement consistently followed either response for two groups.

Observers in the Peg group saw a model pecking the wooden peg, pecking open the tube was always reinforced. Observers in the Ring group saw a model pulling the ring, pulling the ring open was always reinforced. Observers in the Random group saw a model pecking the wooden peg, but there were four sorts of trials: a) Pecking the tube open was reinforced on five trials; b) on five additional trials pecking the tube open was not reinforced; c) on other five trials observers were exposed to the tube but reinforcement was manually presented; d) on five more trials the tube was presented but with no peg and no food. These trials were presented in a mixed order.

Testing phase

A single test session started immediately after the last modeling trial. Testing consisted of presenting each observer with 30 successive test trials; in 15 such trials a tube closed with a wooden peg was presented (peg trials), in the remaining 15 trials a tube closed with a ring was presented (ring trials). The presentation order of peg and ring trials was mixed; opening a tube was always reinforced with 30 millet seeds. A trial ended when a successful response occurred or when 60 s had elapsed; intertrial interval was 45 s in average.

Recording and data analysis

All test trials were videotaped and two experimenters recorded the number of trials with a successful peck. Response categories were developed from previous work (Nieto & Cabrera, 2003). Two independent experimenters then classified behaviors of each bird into the following mutually exclusive categories:

Pecking

Opening the tube by pecking the wooden peg or the base of the rubber stopper when the ring was used.

Pulling

Opening the tube by grasping it with the beak and pulling down either the chain or ring.

Biting

Opening the tube by biting the rubber stopper and shaking it sideways.

RESULTS AND DISCUSSION

Results show that observers in the Peg and Ring groups learned the target response faster than subjects in the Random group. All observers in the Peg group did open a tube at least once, whereas 77% and 33% observers in the Ring and Random groups respectively learned to open the tube.

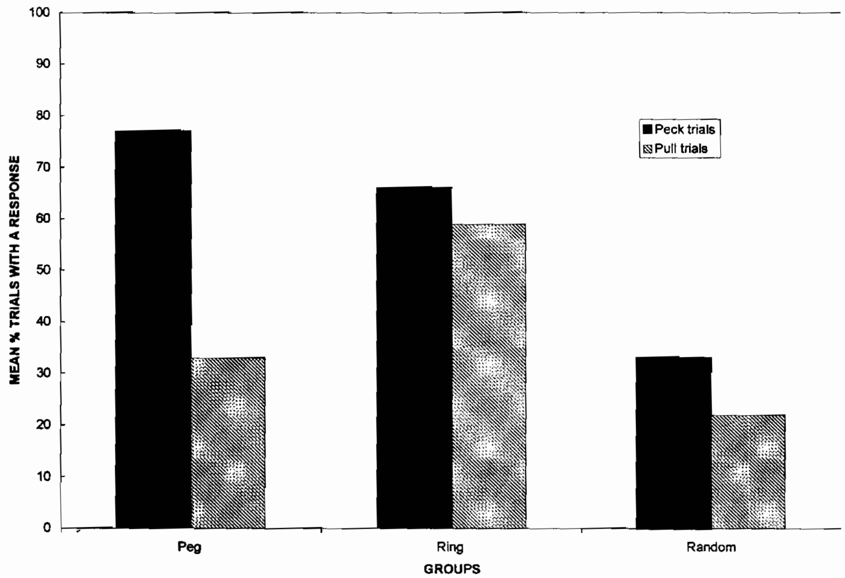

Figure 3. Mean percentage of trials with a successful response for each group in Experiment 2. The data is shown a percentage pecks during the 15 peg trials and pulls during the 15 ring trials.

Figure 3 shows the mean percentage of trials with a successful response for each group; in addition, the figure shows for each group the percentage of pecks during the 15 peg trials and pulls during the 15 ring trials. Observers in the Peg group pecked open the tube in 77% of the peg trials, and in 33% on the Ring trials. Observers in the Ring group pecked (or pulled) open the tube in 66% of the peg trials, and 59% of the ring trials. Observers in the Random group opened 33% of the peg trials, and 22% of the ring trials. These data were analyzed using a mixed factor analysis of variance, groups, and response type was used as factors. Results showed that groups did not differ significantly, $F(2, 24) = 1.62$ $p > .05$; but there was a significant response type effect, F (2,

24) = 3.7 p<. 025. Interestingly, the interaction between groups, and response type was also significant, F (2, 24) = 3.7 p< .05.

Thus, although pecking was a high frequency response in all groups, this effect was modulated by the type of demonstration groups experienced: Pulling was facilitated only in the group that saw the sequence pulling the ring - reinforcement, whereas pecking was facilitated in the group that saw the sequence pecking the peg - reinforcement.

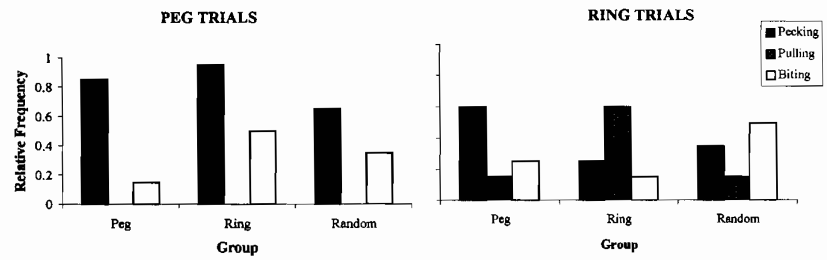

Figure 4. Relative frequencies of three response categories during the test session of Experiment 2. Left-hand side shows relative frequencies of the three responses during the peg trials. The right-hand side shows relative frequencies of the three responses during the ring trials

ANALYSIS OF VIDEO RECORDINGS

Analysis of video recordings of test sessions showed that observers used different responses to open the tubes. Left-hand side of Figure 4 shows relative frequencies of the three responses during the peg trials. It can be seen that pecking was the highest frequency followed by biting the wooden peg for all groups. The right-hand side of Figure 4 shows relative frequencies of the three responses during the ring trials. It can be appreciated that although pecking did occur, pulling and biting increased particularly for the Ring group. Recordings showed that observers in the Peg group would vigorously peck the rubber stopper to which the chain was attached, observers in the Ring group on the other hand would pull the chain or ring to open the tube, and rarely would peck the rubber stopper.

GENERAL DISCUSSION

The present results show that the contingency arranged between the model's responses and the consequent presentation of food is an important factor determining whether learning by observation occurs. Experiment 1 showed that demonstrations of a consistent or predictive relationship between pecking and reinforcement facilitated learning the same response, whereas demonstrations of a random relationship between pecking and reinforcement did not. It also showed that exposing observers to a feeding model or to a model alone does not induce pecking. Experiment 1B attempted to circumvent a limitation of the random procedure used in experiment 1. The Random group in experiment 1 was exposed to six opening responses and to six food reinforcements, whereas the Positive group was exposed to 12 opening responses and to 12 food presentations; thus the unequal number of presentations could account for the differences between those groups. However, a group exposed to the same 12 openening responses and 12 food presentations but in a random order, did not show a similar facilitatory effect as the positive group. Furthermore, although the Peg and Pull groups in experiment 2 also differed in the number of opening responses and food presentations from the Random group used in that experiment, this latter group did not show much evidence of learning despite the fact that they were exposed to 10 opening responses and to 10 food presentations. Thus, we assume that the facilitatory effect of response-reinforcement contingency modeling seem to prevail over unrelated occurrences of the response and reinforcement.

Experiment 2 also showed the influence of the form of the observed response on acquisition of the same or a different response. This experiment showed that although pecking was a preferred response for all pigeons, pulling did have a high frequency for the Pull group. That is, the proportion in which these responses were executed was determined by the particular response that the model had shown during modeling, and not by to the type of operandum present in a given test. This is interesting since it could be assumed that the physical characteristics of the response operanda would solely determine the form of the response that a bird would choose during testing (see also Campbell, Heyes and Goldsmith, 1999; Mitchell, Dawson, and Heyes, 1999; Voelkl and Huber, 2000). These data, together with the evidence reviewed earlier, lend support to the idea that observational learning involves learning that a particular response is associated with reinforcement.

REFERENCES

Akins, C.K. & Zentall, T.R. (1996) Imitative learning in male Japanese quail (*Coturnix japonica)* using the two-action method. *Journal of Comparative Psychology*, *110*, 316-320.

Campbell, F.M., Heyes, C.M. & Goldsmith, A.R. (1999) Stimulus learning and response learning by observation in the European starling, in a two-object/ two-action test. *Animal Behaviour*, *58*, 151-158.

Galef, B.G. Jr. (1995) Why behaviour patterns that animals learn socially are locally adaptive. *Animal Behaviour, 49*, 1325-1334.

Galef, B.G. Jr. (1996) Introduction. En: C.M. Heyes & B.G. Jr. Galef (Eds) *Social learning in animals: The roots of culture*. USA: Academic Press.

Heyes, C. M. (1994) Social learning in animals: Categories and Mechanisms. *Biological Review, 69*, 207-231.

Heyes, C.M. (1996) Genuine imitation? In B.G. Jr. Galef & C.M. Heyes (Eds) *Social learning in animals: The roots of culture*. New York: Academic Press.

Heyes, C.M. & Dawson, G.R. (1990) A demonstration of observational learning in rats using a bidirectional control. *Quarterly Journal of Experimental Psychology, 42 b*, 59-71.

Heyes, C.M., Dawson, G.R. & Nokes, T. (1992) Imitation in rats: Initial responding and transfer evidence. *Quarterly Journal of Experimental Psychology, 45 b*, 229-240.

Heyes, C.M., Jaldow, E. & Dawson, G.R. (1993) Observational extinction: Observation of nonreinforced responding reduces resistance to extinction in rats. *Animal Learning and Behavior, 21* (3), 221-225.

Heyes, C.M., Jaldow, E., Nokes, T. & Dawson, G.R. (1994) Imitation in rats (*Rattus norvegicus*): The role of demonstrator action. *Behavioural Processes, 32*, 173-182.

Lefebvre, L. & Palameta, B. (1987) Mechanisms, ecology, and population-diffusion of socially-learned food-finding behavior in feral pigeons. In P. R. Zentall & B. G. Galef, Jr. (Eds.): *Social Learning: A Psychobiological approach*. New Jersey: Lawrence Erlbaum

Miller, R. & Escobar, M. (2002) Laws and models of basic conditioning. In H. Pashler & R. Gallistel (Eds.): Stevens´handbook of experimental psychology. New York: John Willey & Sons Inc.

Mitchell, C.J., Dawson, G.R. & Heyes, C.M. (1999) Limitations of a bidireccional control procedure for the investigation of imitation in rats: Odour cues on the manipulandum. *Quarterly Journal of Experimental Psychology, 52 B*, 193-202.

Nieto, J. and Cabrera, R. (2003) El papel de los factores asociativos en el aprendizaje social en animales. In J. Vila, J. Nieto y J. M. Rosas-Santos (Eds.): *Investigación contemporánea en aprendizaje asociativo: Estudios en* España y México. Jaén: Del Lunar: Colección Universitas.

Nieto, J., Cabrera, R., Guerra, J. & Posadas-Andrews, A. (1987) Tradiciones alimenticias: difusión de estrategias alimenticias novedosas en animales. *Revista Mexicana de Análisis de la Conducta*, 13 (1), 105-125.

Palameta, B. & Lefebvre, L. (1985) The social transmission of a food-finding technique in pigeons: What is learned? *Animal Learning and Behavior, 33*, 892-896.

Rescorla, R.A. & Wagner, A.R. (1972) A theory of Pavlovian conditioning:

Variations in the effectiveness of reinforcement and nonreinforcement. In: A.H. Black & W.F. Prokasi (Eds) *Classical conditioning II: Current research and theory*, 64-99.

Sherry, D.F. & Galef, B.G. Jr. (1984) Cultural transmission without imitation: Milk bottle opening by birds. *Animal Behaviour*, *32*, 937-938.

Thorpe, W.H. (1963) *Learning and instinct in animals.* Cambridge: Harvard University Press.

Voelkl, B. & Huber, L. (2000) True imitation in marmosets. *Animal Behaviour*, *60*, 195-202.

Zentall, T.R. (1996) An analysis of imitative learning in animals. In: B.G. Jr. Galef y C.M. Heyes (Eds) *Social learning in animals: The roots of culture.* New York: Academic Press.

Zentall, T.R., Sutton, J.E. & Sherburne, L.M. (1996) *True* imitative learning in pigeons. *Psychological Science*, *7*, 343-346.