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RESPONSE

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## **IMITATION IN PIGEONS (*COLUMBA LIVIA*): THE ROLE OF THE CONSUMMATORY RESPONSE**

*IMITACIÓN EN PALOMAS (COLUMBA LIVIA):  
EL PAPEL DE LAS RESPUESTAS CONSUMATORIAS*

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### **Abstract**

Imitation was assessed in three groups of pigeons that observed the whole response-consequence-consumption sequence, only the response and consequence or the response alone. The former two groups were more likely to imitate the response they observed than the latter, which suggests that the observation of the consequence is necessary for imitation to occur, but not the observation of the consumption. These results have implications for theories of perspective taking in animals and for associative conditioning accounts of imitation.

*Keywords:* pigeon, imitation, consummatory response, perspective taking, associative conditioning

### **Resumen**

Se evaluó la imitación en tres grupos de palomas, las cuales pudieron observar una secuencia completa de la actividad del modelo –respuesta, consecuencia, consumo-, sólo la respuesta y la consecuencia, o solo la respuesta. Las palomas expuestas a las

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primeras dos condiciones realizaron la respuesta a imitar con mayor probabilidad que las expuestas a la última condición, lo cual sugiere que la observación de la consecuencia es necesaria para que la imitación ocurra, pero no la observación del consumo. Estos resultados tienen implicaciones para las teorías de toma de perspectivas en animales y para la aproximación del condicionamiento asociativo a la imitación.

*Palabras clave:* Palomas, imitación, respuesta consumatoria, toma de perspectiva, condicionamiento asociativo

Imitation has been defined as the copying or matching of a novel or arbitrary behavior resulting from the observation of that behavior performed by another organism (Zentall, 1988). Empirically, imitation is not easily identified, especially with nonhuman subjects. Because it is difficult to provide a precise operational definition of imitation, ruling out other forms of social influence that might control the behavior of the observer has been the traditional approach to the problem, and imitation is, therefore, identified by exclusion. These other forms of social influence are defined according to the set of stimuli to which the observer is supposed to be attending. For example: a) an observer might attend to the manipulandum instead of the response of the demonstrator; in this case, it might start responding on the manipulandum due to stimulus enhancement rather than imitation per se (i.e. manipulandum, as a lever, is a stimulus that sticks out and the observers might interact with it until pressing it); b) an observer might attend to the response of demonstrator and automatically matching it, independently of its consequences (i.e. copy is observed in domestic parrots emitting human words); c) an observer might attend to consequences of demonstrator responding and matching the response to obtain the consequence, as in an affordance situation, in which the rats might move the door of a dispenser of food to obtain it in absence of demonstrator response (Heyes, 1994; Klein & Zentall, 2003; Zentall, 1996).

In an experimental preparation designed to evaluate imitation, the observer is exposed to a series of visual cues: the presence of the demonstrator, the target response, non-target responses, the presence/absence of a consequence (generally food), and the presence/absence of a consummatory response. The observer might attend to one of these visual cues alone or to a combination of them. True imitation can be asserted with confidence only when the behavior of the observer is the result of the exposure to a response-consequence relation (Heyes, 1994). Thus, careful manipulation of the elements to which the observer might attend is an essential part of any analysis of this phenomenon.

To control for these social but non-imitative influences, several experimental preparations have been designed. Heyes and Dawson (1990) and Heyes, Dawson and Nokes (1992), with rats as experimental subjects, proposed a bidirectional control (a joystick that could be moved right and leftwards). Subjects initially observed a dem-

onstructor moving the joystick to the right or to the left and were later required to perform the same response. The observers in these experiments were more likely to move the joystick in the same direction as the demonstrators had done, and these results were interpreted as evidence of imitation. However, a subsequent experiment showed that both olfactory and taste cues left by the demonstrators on the joystick were sufficient to produce demonstrator-consistent responding (Mitchell, Dawson, & Heyes, 1999).

Other experiments with quails and pigeons as experimental subjects have assessed imitation using two topographically dissimilar actions in the test, such as pecking or stepping on a response pedal (Akins & Zentall, 1996; Zentall, Sutton, & Sherburne, 1996), or using a two objects/two responses test with starlings (Campbell, Heyes, & Goldsmith, 1999). In the former procedure, an observer saw a demonstrator performing one of the responses and was later required to perform similar or dissimilar response topography. In the latter case, an observer saw a demonstrator performing one response when Stimulus A was present (e.g., pulling a ribbon attached to the lid of a food container when the container was red) and another response when Stimulus B was present (e.g., pecking the lid until it sank into the food container giving access to the food when the container was blue). In both cases, observers were more likely to perform a demonstrator-consistent response.

In each of these studies, both imitative and non-imitative aspects of the experimental preparation have been manipulated, such as the presence of the demonstrator, the target response, and the presence of a consequence for responding. In this respect, the role of vicarious reinforcement (the strengthening of responding as result of reinforcement obtained by another organism) has been crucial: observing a demonstrator that did not receive a reward for a particular response topography did not increase the probability of that response topography (Akins & Zentall, 1998). The role of the consummatory response, however, has been largely overlooked. The main question is: when an observer sees a demonstrator emitting a response and producing food as a consequence, does it also have to see the demonstrator eating the food? The data to be obtained in the present experiment allow us to know about of role of different constituents of consequence in the imitative processes, which is relevant because the observation of a response-consequence relationship is deemed paramount to imitation (Tomasello, 2000).

We addressed this question using a simpler procedure that seems to be equally sensitive to the response-consequence relation. In this procedure, a pigeon observes a demonstrator peck a rubber plug attached to a test tube filled with food, releasing its content as a consequence. Previous work in our laboratory showed that control pigeons that saw either the food falling out of the test tube but not the response or a random relation between response and food were less likely to learn the response

than pigeons that observed a contingency between the response and the consequence. Additionally, in a two objects/two responses test, pigeons that observed two dissimilar responses (pecking the plug or pulling a ring attached to the plug) tended to match the response they had observed (Nieto & Cabrera, 2003). The present experiment added two control groups that were prevented from seeing either the consummatory response or both the consequence and the consummatory response. The performance of the pigeons in these two groups was compared to that of group of observers that could see all the visual cues.

## Method

### Subjects

The demonstrator was an adult pigeon (*Columba livia*) that had been previously trained to open tubes containing food. The observer were 24 experimentally naïve adult pigeons (*Columba livia*). All subjects were acquired from a commercial pet store two months prior to the beginning of the experiment. They were all housed individually in an aviary with a 12-hour light-dark cycle. During the course of the experiment, they were kept at 80% of the ad libitum weight, with free access to water in their home cages.

### Apparatus

Figure 1 shows a schematic representation of apparatus that was used in this experiment, which was composed of two identical experimental chambers. They were 25.3 cm long, 15.2 cm wide and 23.5 cm tall, made of wire mesh. Their back and lateral walls and ceilings were covered with black cardboard. The front wall had an approximately circular opening about 6 cm in diameter, 7 cm above the floor, through which the pigeon could stick its head out. The front walls of these two chambers were positioned facing each other and separated by 30 cm; a 20 x 20 cm aluminum tray was placed between the chambers and served as a feeding tray. At the side of each chamber, there was a metallic structure with a clamp sustaining an opaque test tube, 20 cm long and 2 cm in diameter. This test tube could contain 20 millet seeds and was sealed with a rubber plug attached to a wood strip, 4 cm long and 1.5 cm wide. The rubber plug was inserted 1.5 cm into the tube. When the subject pecked the wood strip repeatedly, the rubber plug and the millet seeds fell onto the feeding tray. Depending on the group, a 5 x 20 cm opaque screen was placed in front of the demonstrator's chamber, so that the observer would be able to see the demonstrator and the test tube, but not the feeding tray.

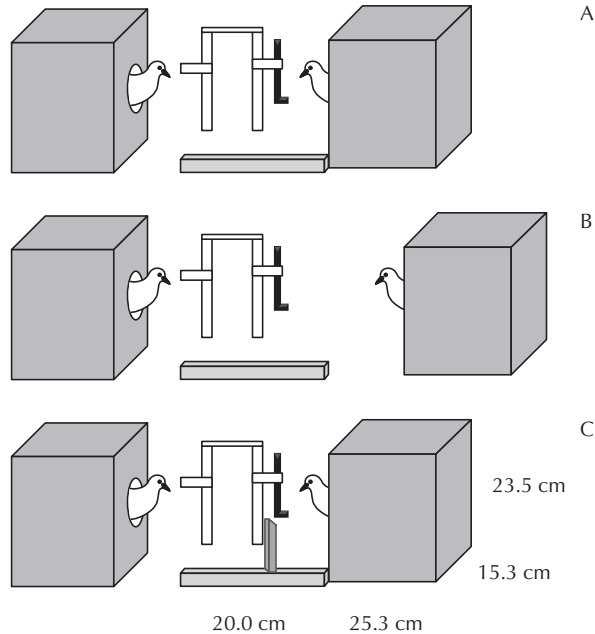


Figure 1. A schematic representation of the apparatus is shown. The observer was placed into the left cage and the demonstrator was placed into the right cage. a) the arrangement for Group RFC, with the tray in which the food fell near to demonstrator cage. b) the arrangement for Group RF, in which the demonstrator's cage was moved away from the tray when the food fell onto it. c) the opaque screen used in Group R. In test trials, the tray was near to observer's cage.

## Experimental setting

Sessions were conducted inside a cubicle, with a table on which both chambers and the tray were placed. Two experimenters sat next to the table. One experimenter presented and withdrew the test tube on each trial; the other experimenter withdrew the demonstrator cage or placed the opaque screen according procedure. Sessions were videotaped with a camera mounted on a tripod and time measures were recorded with a chronometer.

## Procedure

The demonstrator was trained to peck the wood strip by successive approximations until the rubber plug fell onto the feeding tray. The test tube was presented in 1-min trials; the experimenter withdrew the test tube when the demonstrator opened it or 1 min after its presentation, whichever occurred first. A new trial began after a 1-min

intertrial interval, and sessions ended after 18 trials. This procedure was continued until the demonstrator performed the required response in every single trial for three consecutive sessions.

To habituate the observers to the experimental setting, they were placed in the experimental chamber for 15 min a day, for seven consecutive days. During these habituation sessions, the demonstrator chamber was empty, but both experimenters were present.

On the day following the last habituation session, the demonstrator was placed in its chamber and exposed to a sealed test tube with food inside; the observer was placed in its own chamber, with access to neither the test tube nor the food. Observers were randomly assigned to one of three groups. Group RFC was exposed to trials during which the demonstrator performed the required response (pecking the wooden piece to open the test tube), produced food and consumed it (see panel a of Figure 1). Thus, these observers could see the complete sequence of response-food-consumption. Group RF observed the demonstrator performing the required response and producing food, but the experimenter pulled the demonstrator's chamber away from the food tray, preventing it from consuming the food (panel b of Figure 1). So, these observers could only see the response-food sequence. For Group R, an opaque screen was placed between the chambers (panel c of Figure 1), so the observers could only see the required response, but neither food nor consumption. The demonstration consisted of a single 18-trial session, with an intertrial interval and maximum trial duration of 1 min. The sessions were run once a day. In each session, one observer of one of three experimental groups was exposed to demonstrator; which group was run on a particular session was determined randomly.

The demonstrator was re-trained after each experimental session with 20 trials with continuous reinforcement. Thus, the demonstrator emitted the required response in every trial soon after the test tube was placed on the metallic clamp. Each trial began only if the observer had its head oriented towards the frontal wall of its cage.

Immediately after the last demonstration trial, a single test session was conducted, during which the demonstrator was kept in its chamber, with access to neither the test tube nor the food. During each test trial, a sealed test tube, filled with millet seeds, was presented to the observer. The test also consisted of a single 18-trial session, with intertrial interval and maximum trial duration of 1 min.

### **Data recording**

A response was defined as multiple pecks on the wood strip until the rubber plug and seed had to fall onto the feeding tray (a minimum of five pecks was necessary). After data collection, two experimenters independently saw video-recordings of the sessions and each recorded response occurrence and latency. Only records with in-

terobserver agreement of 100% were considered in the analysis. Each video recording was checked until the interobserver agreement was 100; thus, the analysis included the data of all subjects.

## Results

The demonstrator performed the target response in 100% of the trial for each observer in each groups; the mean latencies per group varied between 2.0 and 3.36 s. Table 1 shows the percentage of trials with a response for each of the observers. Except for two pigeons in Group RFC and two pigeons in Group RF, subjects emitted the response in more the 80% of the trials, whereas only two pigeons in Group R emitted the response, and they did so in fewer the 80% of the trials. Given the dichotomous nature of the dependent variable (occurrence of a response in a trial), a binary logistic generalized linear model was fitted to the number of trials with a response with PASW® Statistics 17.0 software package. A 0.05 significance level was used. Preliminary analyses indicated over-dispersion of the data (*deviance/degrees of freedom* = 20.3), so the deviance was used as a scale weight to correct for the underestimation of the standard errors. The model with the group + intercept was not significantly different from the model with the intercept alone, *likelihood-ratio*  $X^2$  (2) = 5.34,  $p$  = .069. Compared to Group R, parameter estimate for Group RFC was significant: belonging to Group RFC increased 13 times the odds of observing a response in a trial, *Wald*  $X^2$  (1) = 3.92,  $p$  = .048, while belonging to Group RF increased it 7.67 times, but the parameter was not significant, *Wald*  $X^2$  (1) = 2.70,  $p$  = .10. Bonferroni pairwise comparisons of the estimated marginal means based on the number of events in a fixed number of trials revealed the proportion of trials with a response for Group R was significantly lower than for groups RFC,  $p$  = .03.

Table 1  
*Percentage of trials with a response and response latencies of observers in different groups. Numbers in parentheses represent standard deviation. Only trials with a response were used to compute latencies.*

Group		RFC	
Pigeon	% trials with a response	Latencies (s)	Trials to first response
1	100.00	4.17 (4.68)	1
2	100.00	4.72 (5.59)	1
3	100.00	5.89 (8.14)	1

(Continued)



Table 1 (continued)

Group		RFC	
Pigeon	% trials with a response	Latencies (s)	Trials to first response
4	0.00		
5	100.00	3.22 (4.94)	1
6	0.00		
7	100.00	2.33 (1.85)	1
8	100.00	2.56 (1.34)	1
Mean	75.00%		
Group		RF	
Pigeon	% trials with a response	Latencies (s)	Trials to first response
1	100.00	6.39 (8.22)	1
2	100.00	2.78 (3.04)	1
3	100.00	4.17 (4.42)	1
4	100.00	2.94 (1.80)	1
5	94.44	6.76 (6.96)	2
6	0.00		
7	88.89	**	1
8	0.00		
Mean	72.92%		
Group		R	
Pigeon	% trials with a response	Latencies (s)	Trials to first response
1	0.00		
2	0.00		
3	0.00		
4	78.78	13.80 (12.71)	2
5	0.00		
6	0.00		
7	0.00		
8	68.68	5.58 (8.75)	2
Mean	18.05%		

\*\* Although this subject responded in most trials, latencies were lost due to a recording error.

Additionally, 100% and 84% of observers in Groups RFC and RF, respectively, emitted the response in the first test trial, while not a single observer in Group R emitted response in the first test trial.

### Discussion

This experiment attempted to separate the effects of the different elements observed by an organism in an observational learning procedure. One group of pigeons observed the complete sequence of response – food production – food consumption, while others observed only response and food production or the response alone. Observing the sequence of response and food production was sufficient to generate higher percent of trials with responses and quickly responding in testing trials which can be seen as a robust demonstration of observational learning. Six out of eight pigeons in Group RF showed evidence of learning (compared to only two pigeons in Group R), even though the demonstrator was not allowed to consume the food it produced. Conversely, observing only the response was not sufficient to generate observational learning.

These results, together with the results of Nieto and Cabrera's (2003), suggest that the higher probability of response in groups RFC and RF is the result of true imitation. Nieto and Cabrera (2003) used a similar procedure and ruled out the emulation of affordances and observational conditioning as possible explanations, because pigeons that observed the removal of the rubber plug performed by the experimenter did not perform any better than a trial-and-error group. So, learning how the mechanism works or the mere association between the rubber plug and food seem to be insufficient to promote responding. In the present experiment, in turn, the responses of the demonstrator in Group R could have arguably increased the salience of the rubber plug or could have functioned as a response to be matched without any relation with the consequence. Yet, this was not sufficient to promote responding either. So, both stimulus enhancement and copy also can be ruled out as possible explanations. We did not have a control group that was not exposed to the demonstrator and we cannot ascertain that they would not respond as readily and as often as Groups RFC and RF. However, given that previous work with similar procedures found no evidence of consistent trial-and-error learning (Cabrera, López, & Nieto, 2005; Nieto & Cabrera, 2003) and that trial-and-error could arguably have played a role in the performance of all groups, but there was a clear difference between Group R and the other two groups, we believe that it is also safe to discard trial-and-error learning as a main source of control. Additionally, the responding of observers in groups RFC and RF might not be attributed to reinforcer delivery per se, because all observers that acquired the target response in Group RFC and 84% in Group RF emitted the target response in the first trial.

The fact that pigeons from Group R were not more likely to respond is consistent with Akins and Zentall's (1998) finding that Japanese quails that observed a nonreinforced demonstrator were not more likely to respond either. These authors concluded that vicarious reinforcement was necessary for imitation to occur in Japanese quails. Their results gain further relevance given the assumption that results from our Group RF, in turn, extend their findings by showing that imitation may occur even when the demonstrator is prevented from eating the food it produces. This result is counter to some accounts of imitation that assume mechanisms of perspective taking or theory of minds (Guillaume, 1971): observing a demonstrator that produces food but is prevented from eating it should not result in imitation if the observer really put itself in the demonstrator's perspective, because the demonstrator's actions lead to nonreinforcement, which is arguably related to frustration in an operational sense (Amsel, 1958).

Our results also suggest that Akins and Zentall's conclusion might need to be qualified with a definition of vicarious reinforcement. If it implies the consumption of the consequence produced, then vicarious reinforcement may not be necessary. Conversely, only the sight of the consequence may be important to vicarious reinforcement and, as such, the presentation of a consequence may be segmented into its different elements to shed light onto the mechanisms responsible for imitation.

In the present case, a stimulus-association account (Zentall, 1996), based on the pairing between the demonstrator's responses with secondary reinforcement (the sight of food), could be a more likely candidate for explanation. Interestingly, it seems that the sight of food, but not other forms of secondary reinforcement, is the most important variable determining performance of the modeled response, at least with pigeons. Group R, which was prevented from seeing the food, but could arguably hear its falling on the tray and the demonstrator's pecking the tray, did not respond as often. This result suggests that stimulus modality may be relevant to response acquisition through modeling when the association between the particular response topography and the stimuli associated with a consequence is involved. On the one hand, the fact that stimulus modality plays an important role in stimulus association has been widely recognized since Garcia and Koelling's (1966) study. The role of stimulus modality in social learning, on the other hand, is hardly mentioned. Further research with other types of primary and secondary reinforcers is needed to evaluate the adequacy of this account.

However, the hypothesis of stimulus association, as it was proposed, has problems of its own (Zentall & Akins, 2001). For example, the tendency to match the demonstrator's response is affected by the observer's deprivation level (Dorrance & Zentall, 2001), but this should not occur if imitation is indeed some sort of second-order conditioning (Holland & Rescorla, 1975). Thus, other conditioning mechanisms may be necessary to explain why observing a response emitted by another organism increases the likelihood of its being emitted by the observer.

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