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IMITATION LEARNING IN BUDGERIGARS: DAWSON AND FOSS (1965) REVISITED

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ABSTRACT

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Dawson and Foss (1965) have reported that each of five naive budgerigars (Melopsittacus undulatus) after watching a demonstrator budgerigar use one of three different methods of opening a covered food dish, used the same method as its respective demonstrator to uncover its own food fish. Our first attempt to replicate Dawson and Foss' experiment was unsuccessful and revealed a number of sources of ambiguity in their methods. Modified procedures, removing these ambiguities, produced results confirming those of Dawson and Foss. However, although observer budgies exhibited a significant tendency to use the same method to uncover a food dish as did their respective demonstrators, the effect was both of brief duration and marginal significance. This relative fragility of the Dawson and Foss' (1965) finding renders it unsuitable as a model system for exploring the phenomenon of imitation learning.

INTRODUCTION

Whether true learning by imitation (Thorpe, 1956) occurs in animals has been a matter of controversy for almost a century. Although both descriptions of behavior and experimental evidence have been reported consistent with the view that animals can "do muscular acts from having seen [others] do them" (Thorndike, 1898, p. 76) in a number of avian and mammalian species, it is rarely the case that such evidence is unambiguous. Failure to control adequately for other types of learning (i.e., local enhancement (Thorpe, 1956), sensory preconditioning, or classical conditioning) is all too common in experimental demonstrations of imitation learning. Properly designed and controlled studies of learning by imitation have rarely been independently replicated. In consequence, almost 100 years of investigation of imitation in animals has failed to produce reliable procedures for demonstrating the phenomenon. Progress in the study of learning by imitation in animals would obviously be greatly facilitated by identification of an experimental procedure in which imitation could be unambiguously and repeatedly demonstrated.

Review of the published literature reveals at least one very promising, yet relatively unexplored, procedure for such demonstration. Dawson and Foss

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(1965) reported that each of five naive budgerigars (Melopsittacus undulatus) that had observed a trained conspecific demonstrator use of one of three distinct methods to remove the lid from a food bowl, subsequently used the same method as its respective demonstrator when uncovering its own food bowl. Those naive birds that had watched a demonstrator use its foot to remove the cover from a food bowl used a foot to accomplish the same end, those observers that had watched a demonstrator grasp and lift the cover with its beak did likewise, and the observer that had watched a demonstrator nudge off the cover with its beak, used that method. Effects on observers of watching a trained demonstrator were of considerable duration. When retested 2 months after first opening food bowls, each observer still used the same motor pattern to uncover its food bowl that it had observed its demonstrator exhibit (Dawson & Foss, 1965).

The procedures described by Dawson and Foss (1965) seem particularly promising for study of imitation learning. The fact that each observer used the same motor pattern as its respective demonstrator (rather than exhibiting reduced latency to achieve reinforcement or transfer of a species-typical response to a previously neutral stimulus) makes this an unambiguous case of imitation, rather than a possible instance of local enhancement or classical conditioning. Further, the use of an inexpensive, easily obtained subject species makes possible both exploration of the phenomenon in depth and replication in numerous laboratories.

EXPERIMENT 1

Dawson and Foss (1965) described their results, based on study of only five subjects, as preliminary and in need of replication. So far as we know, no such replication has been reported in the literature.

Because of the cursory nature of Dawson and Foss' descriptions of their methods, it was not possible to know whether we precisely replicated Dawson and Foss' procedures in the experiment described below. Therefore, in the description of methods presented below, we discuss parenthetically both those areas in which we may have proceeded differently from Dawson and Foss and the reasons for our selection of the procedures we used.

METHODS

Subjects

Forty budgerigars (Melopsittacus undulatus) obtained from Guy's Pet Shop (Hamilton, Ontario) while still in early juvenile plumage, served as demonstrators (N=20) and observers (N=20). As will be seen below, 10 demonstrators failed to meet criteria for inclusion in the experiment and they and their observers were discarded, leaving 10 demonstrators and 10 observers as full participants in the experiment.

Apparatus

A 1.3 x .3 x .3 m Plexiglas enclosure, with wire mesh ceiling and floor, was divided into four equal (.3 x .3 x .3 m) compartments by transparent Plexiglas partitions. Removable opaque partitions permitted the compartments to be visually isolated. Both the apparatus and holding cages for subjects were placed in rooms kept on a 12 hr light/dark cycle (light onset at 0800 hr) with a low level of background white noise.

Behavior of subjects was monitored by closed-circuit television and videotaped for analysis.

Procedure

Habituation. Pairs of subjects were removed from their holding cages and introduced into adjacent compartments of the apparatus, separated by both opaque and transparent partitions. Each pair was then allowed a minimum of 3 days to become habituated to the enclosure. During this habituation period, each subject was maintained on ad libitum seed, gravel and water. Immediately following habituation, each subject was placed on a restricted feeding schedule, receiving 1.5 teaspoons (7.4 ml) of seed and a pinch of gravel once every 24 hr (1200 hr) in a clear glass food-bowl 7 cm diam. x 4 cm high (a standard food-bowl).

Demonstrator training. Following the period of scheduled feeding, one member of each pair of subjects (the demonstrator) was offered its daily ration in a test food-bowl constructed of a 3.5 cm diam. x 1.0 cm high plastic Petri dish mounted for stability on a 5 x 5 cm square of white Bristol-board and covered with a 4 x 4 cm (0.6g) red Bristol-board lid. (Pilot studies had revealed that the motor patterns used by budgies to remove Bristol-board covers from food dishes were strongly influenced by both the weight (or area) of the cover and the height of the top of the food dish above the floor. Large, heavy covers were most frequently grasped with the beak and pulled, twisted or pushed off, as were covers on bowls too high to be reached easily with the foot. Small light covers were pecked once or twice or brushed aside with the body or food. In our experience, a 4 x 4 cm card of Bristol-board resting on a dish less than 2 cm in height elicited the broadest range of motor patterns for its removal. Unfortunately Dawson and Foss (1965) did not specify the dimensions of the food bowls and lids they used in their work.)

Each demonstrator was fed from a test food-bowl until it either used the same motor pattern to uncover its test food-bowl for 5 consecutive days or 21 days had passed without a demonstrator reaching the criterion of consistency. Ten of 20 demonstrators failed to reach criterion in 21 days. Both those demonstrators failing to reach criterion within 21 days and their pair-mates were removed from the experiment. (Dawson and Foss did not report any variability in the behavior of their demonstrators. During training, all of our

demonstrators used more than one motor pattern to remove lids).

Demonstration. Once a demonstrator had met the criterion of consistency in its method of lid removal, the opaque partition was removed from between that demonstrator and its observer. Twenty-four hr following removal of the opaque partition, and every 24 hr for 7 days thereafter, the demonstrator exhibited lid-removal to its observer.

On each demonstration day, a demonstrator was given 7.4 ml of seed in a covered test food-bowl. One min after the demonstrator had removed the lid of its test food-bowl and begun to feed, its observer was given a standard food-bowl containing 7.4 ml of food. (Dawson and Foss provided no information on the feeding of observers during the demonstration phase of the experiment.)

Following its eighth demonstration of lid removal, each demonstrator was removed from the apparatus.

Testing observers. Twenty-four hours after removal of its demonstrator, and every 24 hr thereafter for 7 consecutive days, each observer was offered a lidded test food-bowl containing 7.4 ml of seed. The experimenter video-taped each observer's and each demonstrator's behavior on each of the eight test days for later analysis.

An observer was given 60 min following introduction of a test food-bowl into its enclosure in which to feed. If any observer failed to feed within 60 min of introduction of its food-bowl on any day, it was given a standard food-bowl containing 7.4 ml of seed. (Dawson and Foss do not report how they fed observers failing to uncover the test bowl during testing).

RESULTS

Demonstrators selected according to our criterion were fairly consistent in the method of cover removal they employed during the 8 days of demonstration to observers. Eight of the ten demonstrators employed the same method of lid removal on all 8 days of demonstration; the other two demonstrators used the same method on 6 of 8 days. Five of the ten demonstrators primarily employed their bills to peck or nudge the lid off, two used their bills to grasp and pull the lid, and three used their feet to push the lid aside. All observers appeared to visually fixate their respective demonstrators on most demonstration trials.

Observers, like demonstrators, employed three different motor patterns to remove covers from test food-bowls: they either grasped the edge of the cover with their bills and pulled the cover off, pecked or nudged the cover off with their bill, or used a foot to push or pivot covers from food bowls. Unfortunately, even with the benefit of repeated viewings of video-recordings, there was imperfect agreement among independent scorers as to the method of cover removal used by some subjects on some trials. Grasping with the bill and

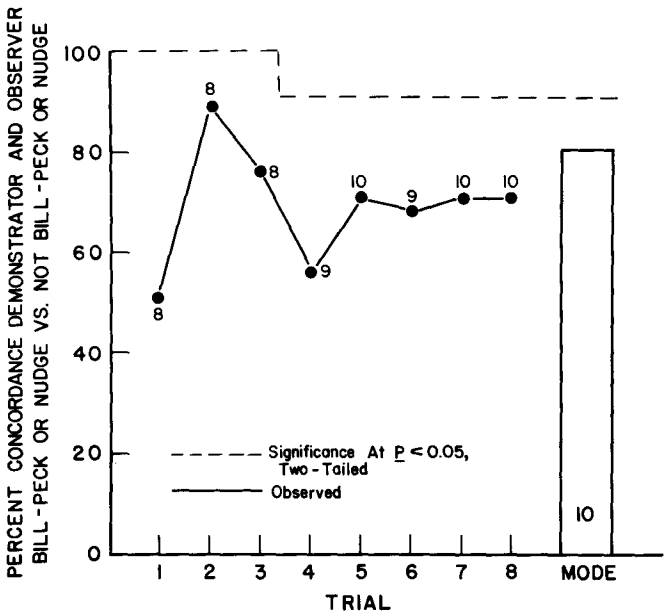

Fig. 1. Percentage of subjects using the same motor pattern that their respective demonstrator had used to uncover test food-bowls on each of 8 days of testing. Number adjacent to points = number of subjects uncovering food bowls on each test day. Histogram indicates the percentage of subjects whose modal motor pattern of cover removal matched that of its demonstrator. The dotted line indicates the percentage necessary for statistical significance at the 0.05 level (Binomial test, two-tailed).

pulling the cover was particularly difficult to discriminate from pecking or nudging of the cover with the bill. Data analyses were based on the modal classification of the method of cover removal by the three independent scorers. Figure 1 shows the percentage of the ten observers whose method of cover removal matched that of their respective demonstrators on each of the eight test trials. Because five demonstrators used their beaks to peck or nudge the cover off test food-bowls and five used either a bill grasp or foot for the same purpose, one can assign a probability of 0.5 to a demonstrator demonstrating the bill-peck or nudge method of cover removal. Because observers used the bill- peck or nudge method on 37 of the 72 test trials on which they fed from test food- bowls (observers failed to feed on eight trials), it is possible to assign a 0.5 probability to the use of bill-peck or nudge by observers on any trial. Hence,

the probability of a match between the behavior of a demonstrator and its observer (treating each observer's behavior as either a bill-peck or nudge or not a bill-peck or nudge) was 0.5. The dashed line at the top of Figure 1 indicates the percentage of matches between the behavior of observers and their respective demonstrators necessary for significance by the Binomial test (two-tailed) on each test day. This value changed with the number of observers feeding on each test day. As can be seen in the figure, although there was a tendency for each observer to use the same motor pattern that its respective demonstrator had used to remove the cover from its test food-bowl, this tendency failed to reach significance on any day of testing.

Only 3 of 10 observers were totally consistent in the method they employed in removing covers from their test food-bowls. Six observers employed two methods of cover removal and one all three methods in the course of eight test trials.

As is also indicated in Figure 1, the most frequently employed motor pattern used by 8 of 10 subjects to remove the covers from their food bowls (an observer's modal method of cover removal) matched that of their respective demonstrators (Binomial test, $N = 10$, $x = 2$, $P = 0.11$, two-tailed).

DISCUSSION

Our attempt to replicate Dawson and Foss' (1965) finding of imitation of motor patterns by young budgerigars produced mixed results. Whereas Dawson and Foss found 5 of 5 observers consistently used the same method to uncover their food bowls as their respective demonstrators, by the most generous interpretation, only 8 of our 10 observers did so, giving a not significant outcome, though one in the predicted direction.

In the course of our replication of Dawson and Foss' experiment, we also uncovered some unexpected methodological difficulties. Dawson and Foss did not report variability in the method used by individual demonstrators and observers to uncover their test food-bowls; many of our birds were quite variable in their behavior. We also experienced considerable difficulty in distinguishing between two of the more commonly employed methods of cover removal, bill-grasp and pull and bill-peck or nudge. Further, like Dawson and Foss, because we had no a priori probability of exhibition of the various motor patterns by observers and demonstrators, we had to take some liberties with the data (combine categories of uncovering and use post hoc probabilities of a match) in order to analyze the data statistically. Experiment 2 was designed to overcome all these methodological problems.

EXPERIMENT 2

In order to determine whether budgerigars will learn by observation to use

a particular motor pattern in uncovering a food bowl one needs, first, to define two or more clearly distinguishable motor patterns to be exhibited by demonstrators and imitated by observers. We selected the use of the beak or the use of the foot to remove a cover. Second, in order to analyze statistically the match between behaviors exhibited by observers and those exhibited by their respective demonstrators, one requires a clearly defined expected probability of a match. We exposed equal numbers of observers to demonstrators using foot and beak to remove covers so that the a priori probability of a match was 0.5. Last, it would surely be helpful if each demonstrator was absolutely consistent in the motor pattern it demonstrated to an observer. To this end, we designed feeding devices that restricted the motor patterns each demonstrator might use. The resultant experiment allowed us to reach some conclusions as to whether the removal of covers from food dishes by budgies might provide a model system for the study of imitation learning.

METHODS

Subjects

Thirty budgerigars obtained from Guy's Pet Store (Hamilton, Ontario), while still in early juvenile plumage, served as demonstrators (N=8) and observers (N=22) in the present experiment.

Apparatus

The experiment was conducted in the same enclosures described in Methods of Experiment 1.

Food was presented to demonstrators and observers in feeding devices of the type illustrated in Figure 2. Each device consisted of: (1) a 5.0 x 7.5 cm platform to which was attached a 2 cm diam. x 1 cm high circular plastic food dish, (2) three pieces of 0.5 cm diam. wood dowling (2 cm in height) and (3) a 12 x 5 x 5 cm transparent Plexiglas shield, restricting subject access to the food dish. Each feeding device was anchored to the screen floor of the enclosure (about 1 cm from the transparent partition separating demonstrator and observer) and oriented with the open side of the shield at right angles to the partition.

Covers for food dishes were constructed of keyhole shaped pieces of red Bristol-board (weighing an average of 0.5 g) and stainless steel straight pins inserted between the layers of the Bristol-board and glued in place. The construction of covers and dowels was arranged so as to constrain subjects to use particular motor patterns to remove covers from food dishes.

Tip-device (Illustrated in Figure 2). The single dowel at the back of the feeding device had a vertical slit cut in it and the pair of dowels at either side of the Plexiglas shield had quarter-circular wedges cut from their front faces. To remove the cover from a tip device, a subject had to push downward on

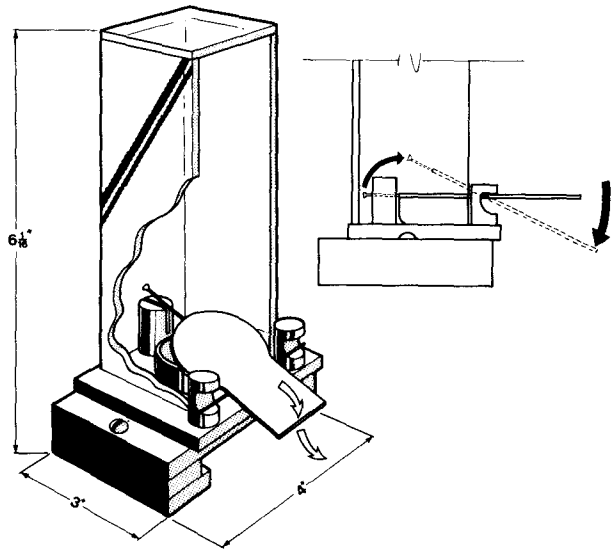

Fig. 2. A tip feeding device of the type used in Experiment 2.

the top of the rectangular tang of the cover, thus rotating the pin at the back of the cover upward and out of the slit in the dowel at the back of the feeding device. The action of gravity then caused: (1) the pair of pins at the sides of the cover to slide down the wedges cut in the faces of the pair of dowels at the sides of the feeding device and (2) the cover to slide down the front face of the food dish and out of the way.

Pull-device (not illustrated). The construction of pull devices was similar to that of tip devices with the following exceptions: (1) The head was removed from the pin attached to the round end of the key-hole shaped cover. (2) The single dowel at the back of the pull device had a hole drilled through it, parallel to the cage floor, rather than a vertical slit cut in it. (3) The pair of dowels to either side of the shield had slits parallel to the cage floor, rather than quarter-circular wedges, cut in them. For a subject to remove the cover from a pull device it had to grasp the cover with its beak and pull the cover straight forward parallel to the floor.

Tip-or-pull device (not illustrated). Tip-or-pull devices were identical to tip devices except that the head was removed from the pin at the round end of the cover of tip-or-pull devices. The cover of a tip-or-pull device could be

removed either by grasping the rectangular tang of the cover in the bill and pulling straight forward or by applying downward pressure to the tang of the cover with foot or bill to rotate the cover into a vertical orientation.

Procedure

Training demonstrators. Three budgerigars were trained to remove covers from pull devices and five to remove covers from tip devices. To begin, each demonstrator was left in an enclosure with an empty feeding device without a cover in place and food-deprived for 24 hr. At the end of the period of food deprivation, the feeding device was removed from each demonstrator's enclosure, the food dish was filled with 7.4 ml of seed, an appropriate cover inserted in place, and the feeding device replaced in each demonstrator's enclosure.

The experimenter observed the behavior of each demonstrator on closed circuit television, recording both the method used by each demonstrator to remove the cover and each demonstrator's latency to begin feeding. Demonstrator training trials were repeated daily until each demonstrator was reliably uncovering its food dish and eating within 1 min of placement of the feeding device in its enclosure. Only those demonstrators that used their bills to remove the covers from pull devices (3/3) and those that used their feet to remove covers from tip devices (3/5) for 10 consecutive trials were retained for use in the experiment proper.

Training observers. Once the six demonstrators were reliably uncovering their food bowls using the appropriate method, an observer was introduced into the enclosure adjacent to each demonstrator, separated from it by a transparent barrier. Each observer was then food deprived for 24 hr.

On each of 9-12 demonstration days, each demonstrator exhibited cover removal using either its foot or bill. One minute after a demonstrator had exhibited cover removal, its observer was given a feeding device containing 7.4 ml of seed in an uncovered food dish. On each trial, the experimenter watched both demonstrator and observer to ascertain both the method of cover removal used by the demonstrator and whether the observer was visually fixating its demonstrator.

Testing observers. On each of 5 test days, each observer was given, 1 min after its observer had begun to eat, a pull-or-tip feeding device with its cover in place and 7.4 ml of seed in the food dish. Behavior of both demonstrator and observer was video-taped on each test trial and later scored by two independent observers.

RESULTS

All six demonstrators were completely consistent in the method they employed in opening food dishes in all demonstration and test trials: Those demonstrators with pull-devices used their beaks to remove covers, those

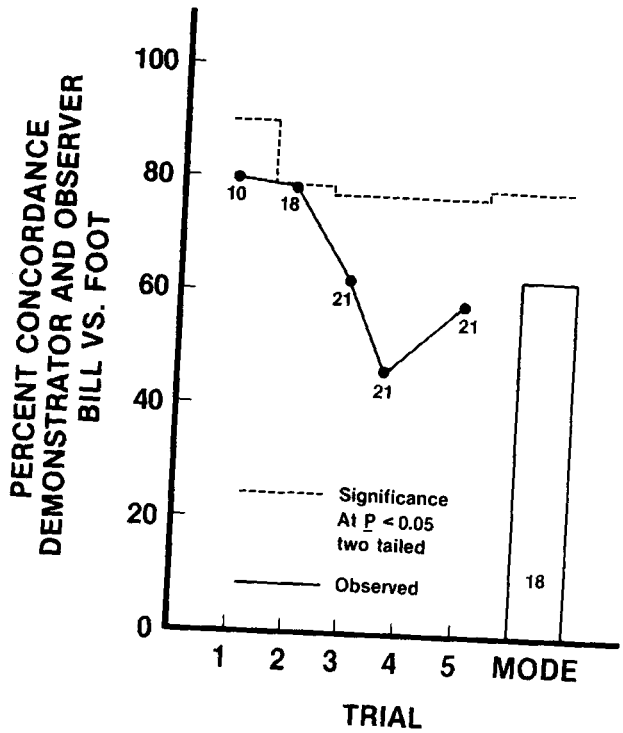

Fig. 3. Percentage of subjects in Experiment 2 using the same appendage (foot or beak) as their respective demonstrators to uncover food bowls on each of 5 days of testing with tip-or-pull feeding devices. Number adjacent to points = number of subjects uncovering food bowls using foot or beak on each test day. Histogram indicates the percentage of subjects whose modal motor pattern of cover removal matched that of its demonstrator.

demonstrators with tip-devices used their feet to remove covers. Observers reliably visually fixated their demonstrators during the period when demonstrators were removing covers (two observers that failed to do so and faced away from their demonstrators during demonstrations were discarded and replaced). There was complete agreement between the two independent observers as to the method (foot or bill) used by both demonstrators and observers on each trial.

The main results of the present experiment are presented in Figure 3 which shows the percentage of observers using the same method as their respective demonstrators to remove covers on each of the 5 days of observer testing. As

TABLE I

Appendage used by observers as a function of appendage used by demonstrators in uncovering feeding devices

Appendage used by demonstrator	Appendage used by observer			
	Foot	Bill	other	Total
Foot	25	16	14	55
Bill	18	32	5	55
Total	43	48	19	110

can be seen in Figure 3 there was a tendency on Day 1 and 2 of testing for observers to use the same appendage as their respective demonstrators to open food cups. This tendency of observers to employ the same appendage in opening food cups as their respective demonstrators reached significance on Day 2 of testing (Binomial test, N=23, x= 5, $p < .05$, two-tailed), but was not evident on Days 3, 4, or 5.

As can also be seen in Figure 3, 11 of 18 observers (63%) used the same appendage as their respective demonstrators on a majority of their five test trials. There was, thus, no significant tendency across all observers on all trials to match the behavior of their respective demonstrators. (Four of 22 observers used a part of the body other than beak or foot on one trial and used foot or beak on each of 2 of the 4 remaining trials. These four observers did not have a modal pattern of response, so data from only 18 observers is presented in the histogram labelled mode in Figure 3).

Table 1 presents data describing the behaviour of all 22 subjects on the 110 trials of the experiment. As can be seen in Table 1, observers used some portion of their body other than foot or bill to open their feeding devices on 19 of 110 trials, usually striking the cover with their chests. Observers matched their behavior to that of their respective demonstrators in 57 of the 91 trials (63 percent) on which they used foot or bill to open feeding devices. Analysis of the trials on which observers used foot or bill to open feeding devices but failed to match the behaviour of their demonstrators (39 percent of trials on which demonstrators used their feet to open feeding devices and 36 percent of trials on which demonstrators used their bills for the same purpose) reveals no tendency for observers to prefer one motor pattern to the other in acquiring access to food.

DISCUSSION

The methods employed in the present experiment successfully removed many of the problems in procedure identified in our first attempt (Experiment 1) to replicate directly Dawson and Foss' (1965) methods: (1) the motor patterns used by demonstrators and observers to uncover food dishes were readily discriminable. (2) Demonstrators were consistent in the method they employed in uncovering food dishes and (3) the probability of a match between demonstrator and observer in method of uncovering the food dish could be defined as a priori as 0.5. Unfortunately, with ambiguities removed, the effects of demonstrations of cover removal on observer behavior were of only marginal significance and limited duration.

GENERAL DISCUSSION

The results of the present series of studies suggest that Dawson and Foss (1965) were correct in asserting that naive budgerigars will employ one motor pattern rather than another as a result of observing the behaviour of a conspecific demonstrator. This replication is in itself of some importance, as it is so far as we know, the first independent replication of a controlled experiment in which an animal learned "to do muscular acts from having seen [others] do them."

Unfortunately, two years of work in our laboratory has failed to produce evidence of imitation learning as robust or long lasting in its effects as that which Dawson and Foss reported. Thus, although the data from our experiments is consistent with the hypothesis that budgerigars are capable of learning by imitation, the fragility of the phenomenon, at least in our hands, suggests that the present preparation is not appropriate for extended analyses of the conditions under which imitation learning occurs.

ACKNOWLEDGEMENT

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