Campbell, Ed. (Aldine-Atherton, Chicago, 1972), p. 136

p. 136.
5. R. L. Trivers, Am. Zool. 14, 249 (1974); R. D. Alexander, in Annual Review of Ecology and Systematics, R. F. Johnston, P. W. Frank, C. D. Michener, Eds. (Annual Reviews, Palo Alto, Calif., (1974), p. 325. D. E. Dumond, Science 187, 713 (1975).
 B. Latané and J. M. Darley, Am. Sci. 57, 224

Little, Brown, Boston, 1971).

17 June 1975; revised 17 November 1975

# Pigeons Can Learn Identity or Difference, or Both

Carter and Eckerman (1) found that one can predict a pigeon's ability to learn a symbolic matching or simple matching task from its ability to make simple simultaneous and successive discriminations. On the basis of these data they concluded that in both symbolic matching and simple matching, pigeons learn simple if-then relations. For instance, in the case of simple matching, if the sample is red then a response to red will be reinforced with food; in the case of symbolic matching, if the sample is red then a response to a vertical bar will be reinforced with food. They concluded that "the ease with which both matching and symbolic matching are learned is independent of the similarity between sample and comparison stimuli." While their analysis is ingenious, their conclusion that "identity ... plays no role for pigeons" is overstated.

First, one must be particularly cautious about maintaining that a difference between two treatments does not exist, particularly when conditions are not optimal to observe such a difference. A more direct method for determining if matching and symbolic matching were learned at different rates would be with four equally discriminable colors, with responses to the same color reinforced in the simple matching task and those to a specified other color reinforced in the symbolic matching task. If colors alone were used, then it would not be necessary to differentially scale the abscissa for the different stimulus classes (colors or shapes).

Second, the learning measure used by Carter and Eckerman may avoid the problem of stimulus novelty, but transfer to new stimuli following matching training may provide a more sensitive measure of identity learning.

Our data from pigeons indicate that the identity relation can be learned. Pigeons were trained to either match a sample shape (matching) or mismatch a sample shape (oddity). They were then shown new stimuli that differed from one another only in color, and were trained to either match or mismatch colors. For half the pigeons the second task was of the same type as the training task, matching or oddity (nonshifted groups). For the remaining birds the second task was different from the training task (shifted groups). If pigeons can learn the identity and difference relations, then the nonshifted groups should learn the second task faster than the shifted groups.

Eight domestic pigeons were maintained at 80 percent of their free-feeding weights. Each bird was placed in a cubicle containing an opening through which the bird could eat mixed grain when an externally mounted food tray was raised. Above the opening were three horizontally mounted response keys, each consisting of a 2.5 by 2.5 cm piece of translucent Plexiglas attached at the top edge to a microswitch. A miniature projector behind each response key projected onto the response key one of two shapes (a white circle or cross) on a black background, or one of two colored fields (red or green) (2). The birds were trained to eat from the food tray and were then shaped to peck the center key, which was alternately illuminated with the circle and the cross; pecks were followed by 3second access to grain. Once the key-pecking response was well established the pigeons were divided into two groups. One was given matching training, the other oddity training. Each trial started with the projection of either the cross or the circle on the center key. Five pecks to the center key illuminated the side keys and a single peck to either side key terminated the trial and initiated a 5-second intertrial interval.





The stimulus on one of the side keys was the same as the sample, while the stimulus on the other was different from the sample (the other shape). For pigeons given matching training, pecks to the side key that matched the sample were reinforced. For those given oddity training, pecks to the nonmatching side key were reinforced. Sample shape and the side on which the correct shape appeared were counterbalanced within each session. Each of the 40 training sessions consisted of 96 trials. All birds were then given ten transfer sessions consisting of matching or oddity training with the colors red and green. For each of the training groups (matching and oddity), half were tested on the same concept as during training (nonshifted), and half on the other concept (shifted). This design allowed for a sensitive measure of concept transfer since it could assess immediate transfer effects as well as differences in learning rates between the shifted and nonshifted groups.

The difference between matching and oddity performance on the first task was not significant (3) in analyses of either a learning-rate measure (number of sessions to 65 percent correct) (F = 1.07; d.f. = 1, 6) or a measure of the final level of performance (performance during the last five training days) (F = 2.27; d.f. = 1, 6). On session 40 mean overall performance was 91.8 percent correct.

The transfer data are presented in Fig. 1. A two-way analysis of variance on pooled data for the first four transfer sessions indicated that nonshifted birds performed significantly better than shifted birds (F =8.02; d.f. = 1, 4). By session 4 nonshifted birds were near asymptotic performance. Oddity performance was somewhat better than matching although the difference did not reach statistical significance (F = 5.49; d.f. = 1, 4). The interaction was also not significant (F = 1.46; d.f. = 1, 4). A similar analysis for the learning-rate measure indicated that nonshifted birds learned significantly faster than shifted birds (F =10.00; d.f. = 1, 4). Again, the matchingoddity difference and interaction were not significant (for both, F < 1). On transfer session 10 mean overall performance was 87.2 percent correct. Chance performance on the first transfer session by both groups, due perhaps to stimulus novelty, suggests the importance of using an extended transfer test.

The results indicate that pigeons tested under the proper conditions can show evidence of learning the relations same or different (or both) with a similar problem involving new stimuli. These results support and extend previous findings that pigeons can learn these relations, as evidenced by differential transfer to new stimuli along the training dimension (color) or to new stimuli on a different dimension (color to brightness and brightness to color) (4), and that pigeons can learn complex visual concepts (5).

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#### **References and Notes**

- 1. D. Carter and D. Eckerman, Science 187, 662
- 2. Brightness of the colors and shapes was equated at 8.0 lu/m<sup>2</sup>, measured at the surface of the response keys by a United Detector Technology optometer 40A, with photometric filter and diffuser. Projectors used General Electric 1820 lamps at 24 volts. 3. The .05 level of significance was adopted for all
- R. Malott *et al.*, *Psychol. Rec.* 21, 545 (1971); T.
   Zentall and D. Hogan, *J. Exp. Psychol.* 102, 393 (1975);
   R. Herrstein and D. Loveland, *Science* 146, 549
- R. Herrstein and D. Loveland, Science 146, 549 (1964); R. Lubow, J. Exp. Anal, Behav. 21, 475 (1974); J. Poole and D. Lander, Psychonom. Sci. 25, 157 (1971); R. Siegel and W. Honig, J. Exp. Anal. Behav. 13, 385 (1970). Supported by NIMH grant 24092. We thank J. Levine, D. McBurney, and S. Zentall for their valuable suggestions.
- 6.
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- 9 May 1975; revised 3 September 1975

We (1) have shown that for matching and symbolic matching problems, the rate at which such complex discriminations are learned by pigeons may be predicted from the learning curves of the simple component discriminations. We concluded that there was no basis for believing that identity between a sample and one of the comparison stimuli plays a role for pigeons. Zentall and Hogan (2) seem to have taken this statement to mean that identity cannot play a role for pigeons. Indeed, it would have been more appropriate for us to have said that identity played no role in our experiment, and that there were no data available in the literature to suggest that identity ever played a role. We never meant to say that there is no experimental procedure which could be used to establish a true matching or oddity learning set with pigeons as subjects.

If the substance of Zentall and Hogan's comments on our work was merely an objection to our conclusion, we would simply apologize for the confusion. However, Zentall and Hogan cite data from their laboratory which, according to them, show that identity does play a positive role. We believe that they have no basis for this conclusion within the context of their experiment. We show here that (i) their data do not meet the accepted criterion for demonstrating that the behavior of their birds is governed by a single rule, that is, either matching or oddity; (ii) they have failed to include essential control groups; and (iii) their data show evidence of negative rather than positive transfer.

It is customary to conclude that behavior is governed by a single rule (such as a matching or oddity principle) only when 30 JANUARY 1976

subjects respond to novel stimuli with a level of accuracy greater than that which would be expected by chance. When this criterion is applied to figure 1 in Zentall and Hogan's comment (2), the accuracy of subjects in both the shifted and nonshifted groups is slightly below chance level (50 percent correct) rather than above chance.

Zentall and Hogan dismiss this finding by arguing that an extended transfer test is more appropriate because the rate of learning is a more sensitive measure of concept acquisition than is performance upon the first exposure to novel stimuli. However, a careful inspection of their data leads us to believe that the birds in both groups learned at almost the same rate once they began to learn (3). The major difference between the two curves occurs because birds shifted from a matching to an oddity task (or vice versa) began to learn one session later than pigeons in the nonshifted group. Why don't Zentall and Hogan argue that shifting from matching to oddity (or from oddity to matching) interferes with learning the second task?

The problem with their experimental design is that they do not compare their shifted and nonshifted groups to subjects trained initially on color matching or color oddity tasks. This omission is especially surprising because they seem to have collected the appropriate data. As far as we can determine, data that they reported earlier (4) provide an appropriate control. In the first experiment reported in (4), pigeons were trained either to match red and green stimuli or to choose the odd color. The stimuli and apparatus used, as well as the training procedures employed, appear to be identical in both studies.

When the control data are compared to the two curves in figure 1 from (2), the control curve closely resembles the data from

## the nonshifted group. A one-tailed sign test (5) was applied to the data to test the hypothesis that nonshifted subjects learned more rapidly than control subjects without training on previous problems. The two groups did not differ significantly (P =.377). Therefore, we cannot accept Zentall and Hogan's conclusion (2) that training on the first discrimination problem in the nonshifted group facilitated learning of the second task.

We also compared the shifted and control subjects and found that the groups were significantly different. Learning of the first complex discrimination by subjects in the shifted group interfered with learning of the second problem. According to the sign test, this result would be very unlikely to occur by chance alone (P = .011, onetailed test). Apparently, this difference completely accounts for Zentall and Hogan's results (6).

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#### **References and Notes**

- 1. D. E. Carter and D. A. Eckerman, Science 187, 662 (1975)2
- T. Zentall and D. Hogan, ibid. 191, 408 (1976). We arrived at this conclusion by shifting the curve for the nonshifted birds one session to the right in figure 1 of (2) and comparing the corresponding data points at each position along the abscissa. In a sign test, the two groups did not differ significantly.
- 4. T. Zentall and D. Hogan, J. Exp. Psychol. 102, 393 (1974).
- 5. S. Siegel, Nonparametric Statistics for the Behav-ioral Sciences (McGraw-Hill, New York, 1956), pp. 68-75.
- There is margin for error in our use of the sign test 6. because the analysis was based on numbers esti-mated from Zentall and Hogan's graphs (2, 4). However, we do not believe that having the origidata from which these figures were plotted nal would lead to any changes in our conclusions

2 December 1975

# **Exchange of Water During Lactation**

Baverstock and Green (1), using tritiated water as a tracer, have shown that in some desert species there is a transfer of water from sucklings to their mothers, which apparently results from the consumption of the young's urine and feces by the mother. Recently, we have observed transfers of tritiated water in laboratory rats. This exchange appears to be due almost entirely to the consumption of the young's urine by the mother since, when we prevent micturition by urethral ligation

Table 1. Effect of urethral ligation on the transfer of tritiated water from suckling rats to their mother and littermates. Two 10-day-old rats from each of six litters of eight pups were injected subcutaneously with tritiated water (25  $\mu$ c per rat in 0.25 ml of 0.15*M* NaCl) and then returned to their mother and littermates (control). After emptying of the bladder and ligation of the urethra under ether anesthesia, two pups taken from

each of six other litters were identically injected and returned to the litter (ligated). After 24 hours, samples of blood serum from the mother and uninjected littermates (pooled samples) were measured for radioactivity (liquid scintillation counter). Values are the mean  $\pm$  the standard error; dpm, disintegrations per minute.

Group	Tritium in serum (dpm/ml) from	
	Mother	Uninjected littermates
Control Ligated	$21,648 \pm 1,937 \\ 1,381 \pm 128$	$\begin{array}{c} 6,490 \pm 552 \\ 3,496 \pm 102 \end{array}$