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 (1975).
2. Brightness of the colors and shapes was equated at $8.0\ \mathrm{lu/m^2}$, 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 analyses.
4. R. Malott *et al.*, *Psychol. Rec.* **21**, 545 (1971); T. Zentall and D. Hogan, *J. Exp. Psychol.* **102**, 393 (1974); *Am. J. Psychol.* **88**, 233 (1975).
5. 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).
6. Supported by NIMH grant 24092. We thank J. Levine, D. McBurney, and S. Zentall for their valuable suggestions.

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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 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 ($P = .011$, one-tailed 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).
3. 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 Behavioral Sciences* (McGraw-Hill, New York, 1956), pp. 68–75.
6. There is margin for error in our use of the sign test because the analysis was based on numbers estimated from Zentall and Hogan's graphs (*2, 4*). However, we do not believe that having the original data from which these figures were plotted would lead to any changes in our conclusions.

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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 μc per rat in 0.25 ml of $0.15M$ 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 ± the standard error; dpm, disintegrations per minute.

Group	Tritium in serum (dpm/ml) from	
	Mother	Uninjected littermates
Control	21,648 ± 1,937	6,490 ± 552
Ligated	1,381 ± 128	3,496 ± 102

of the pups which were injected with tritiated water, transfer of tritium to the mother is nearly eliminated. On the basis of measurements of the amount of tritium recovered from the mother and the activity of urine from ligated pups, we estimate that the mother rat on day 10 of lactation consumes approximately 21 ml of urine from a litter of eight. Thus, the mother is reclaiming nearly two-thirds of the water she loses to the pups in milk (*2*).

In addition to observing a transfer from the young to their mother, we also have obtained evidence for a significant exchange of water between littermates. As can be seen in Table 1, urethral ligation of injected pups, which resulted in a 94 percent decrease in the tritium recovered from the mother, only reduced the amount of tritium found in the plasma of uninjected littermates by 46 percent. Thus, at least half of the tritiated water found in uninjected pups appears to be derived not from milk, but rather directly from injected littermates. We believe this exchange between littermates most likely results from the inhalation of tritiated water which is evaporated by the injected pups.

In conclusion, our results suggest that there are two mechanisms of water conservation in the mother-litter group: the reclamation of water lost in milk through the mother's consumption of her young's urine, and the sharing of evaporated water by closely huddled siblings. It appears, therefore, that the model that Baverstock and Green (*1*) propose to describe routes of exchange of water during lactation needs to be refined to include, in addition to the exchange between the mother and young, a transfer between littermates.

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References and Notes

1. P. Baverstock and B. Green, *Science* **187**, 657 (1975).
2. This estimate, which does not account for water loss from the mother to the environment, is based on the assumptions that rat milk is 73 percent water [T. D. Luckey, T. J. Mende, J. Pleasants, *J. Nutr.* **54**, 345 (1954)] and that the mothers in our groups on day 10 of lactation are producing 48 g of milk. This amount of milk production was determined by extrapolating the weight gain of pups that occurs during a bout of suckling after an 8-hour separation from the mother [M. I. Friedman, *J. Comp. Physiol. Psychol.* **89**, 636 (1975)]. In this latter experiment, the bladders of the deprived rat pups were emptied immediately before returning them to the mother to nurse, and weight gain was measured over a 90-minute period. The milk supply appeared to be exhausted at this time since another litter of deprived sucklings which were given to the mother at the end of this 90-minute period did not gain weight despite attempts to suckle.
3. Supported by NIMH postdoctoral fellowship MH-54187 (to M.I.F.) and NIH grant MH-25140 (to Edward M. Stricker).

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Friedman and Bruno have shown that there is pulmocutaneous exchange of water between littermates. They draw two conclusions: (i) the original model of water exchange in lactation (*1*) needs to be refined to include transfer between young and (ii) the transfer is important in water conservation of the mother-litter group.

Considering the first point, let us see how pulmocutaneous exchange (PCE) will influence the curves described (*1*) for the mother, injected young, and uninjected young. From their table 1, it appears that PCE will have a minor influence on tritium levels in the mother; PCE will influence tritium levels in the injected young because they too inhale tritiated water from the environment. But, because they contain tritium at high concentrations, the proportional influence will again be negligible. Thus the only compartment in which the tritium level is seriously influenced by PCE is the uninjected young. This probably explains results obtained when the original model (*1*) was simulated on the computer. Attempts were made to fit data obtained from lactating *Mus musculus* to curves predicted from the model (*2*). It was found that while the observed curves for the mother and injected young were close to those predicted, the uninjected young had observed levels of tritium considerably higher than those predicted. From the results of Friedman and Bruno, it seems most likely that the discrepancy is due to PCE between littermates of *Mus musculus*. Hence the model does need to be refined to include transfer between littermates.

However, we do not believe that sharing of water between littermates is an important mechanism of water conservation in the mother-litter group. Friedman and Bruno injected their 10-day-old rats (probably containing about 20 g of body water) with 25 μc [about 50×10^6 disintegrations per minute (dpm)] of tritiated water. Thus at equilibrium, the body water of the injected pups contained about 2.5×10^6 dpm/ml. Each uninjected ligated young contained, after 24 hours, 3496 dpm/ml (their table 1), or a total of about 70,000 dpm. Each uninjected young must therefore have received by PCE approximately $70{,}000/(2.5 \times 10^6)$ ml of water from the two injected young; that is, approximately 0.015 ml per young. They used litters of eight, so each pup received a total of 0.12 ml/day by PCE from its littermates. The net "saving" in water to the entire litter is therefore about 1 ml/day. This seems small compared with the 21 ml of urine per day consumed by the mother.

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2. P. Baverstock and S. Elhay, unpublished data.

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