Interference and Forgetting in Bird and Fish

Abstract. *Retention in the pigeon and in the goldfish was measured 1 day or 2 weeks after the mastery of each of a series of color discriminations. The amount of forgetting in the pigeon increased with the number of prior problems and increased more rapidly at the longer than at the shorter interval. The amount of forgetting in the goldfish was independent, at both intervals, of the number of prior problems. These results point to the operation of different memory mechanisms in the two animals.*

That learning of one problem may impair the retention of a subsequently learned problem (an effect termed proactive interference) long has been known in man. Proactive interference occurs also in rats (*1*), but comparative studies of habit reversal suggest that it may not be a perfectly general phenomenon of vertebrate learning. There is good reason to believe that the progressive improvement in habit reversal found in mammals and birds is due in large part to proactive interference (*2*). The fact that reversal becomes less and less difficult for these animals as training continues may be explained on the assumption that the preference to be reversed in each problem, which is the preference established in the immediately preceding problem, tends increasingly to be forgotten in the interval between problems. If proactive interference produces progressive improvement, it should be found in animals, such as rats and pigeons, that show progressive improvement, but not in animals, such as goldfish, that do not (*3*). The correctness of this conclusion, which has some interesting implications for the evolution of memory mechanisms, is indicated by an experiment on the forgetting of color preferences in pigeons and goldfish as a function of prior training.

A group of 24 White Carneaux cocks and a group of 24 goldfish (3 to 4 inches long), all animals experimentally naive, were maintained in the laboratory under standard conditions and trained to discriminate color in fully automated choice situations (*4*). Each pigeon worked in a ventilated picnic chest containing an aluminum panel which displayed two circular targets of translucent Plexiglas (one on the right, the other on the left) and the aperture of a grain feeder. Each goldfish worked in its individual living tank, which was carried to a black Plexiglas enclosure. Mounted on the lid of the enclosure were two circular targets of translucent Plexiglas which were lowered into the water of the tank (one on the right, the other on the left) as the lid was brought down. The feeder dispensed live *Tubifex* worms.

There were 40 trials in each experimental session. Each trial began, after a 6-second interval between trials in darkness, with the illumination of the two targets, one with red and the other with green light, the positions of the two colors being alternated from trial to trial in quasi-random order. The animal chose between the targets—a pigeon by pecking, a goldfish by nosing or striking at one of them. If the choice was correct, the target lights were turned off, the feeder light was turned on, and the animal was rewarded—the fish with a worm, the pigeon with access to grain for 3 seconds. Incorrect choice was followed by a 6-second time out in darkness, after which the correct target alone was illuminated, and the animal was rewarded for response to it (guidance).

In the original problem (R_0), each animal was trained to select one of the two colors. The criterion of learning was no more than six errors in a given session and no more than three errors in the last 20 trials of the session. Retention was tested in a subsequent 40-trial session in which the animal continued to be rewarded for choice of the previously correct color. For half of the pigeons and half of the goldfish, the interval between attainment of the criterion and the test of retention was 1 day; for the remaining animals, the interval was 2 weeks. On the day after the test, reversal training (R_1) was begun—choice of the previously unrewarded color now being rewarded—and continued until the same criterion as before was met. One day or 2 weeks later, there was a 40-trial test of retention in which the rewarded color of R_1 continued to be rewarded. Then there were two more reversals (R_2 and R_3), each followed after 1 day or 2 weeks by a retention test. In all, there were four problems (the original discrimination plus three reversals) and four tests of retention. For each animal, two of the retention tests were made after the shorter interval (1 day) and two were made after the longer interval (2 weeks), in balanced orders. Six pigeons and six goldfish were assigned to each of four orders: short-long-short-long, long-short-long-short, short-long-long-short, and long-short-short-long. During the long intervals the animals were cleaned and fed as usual each day, but were given no discrimination training.

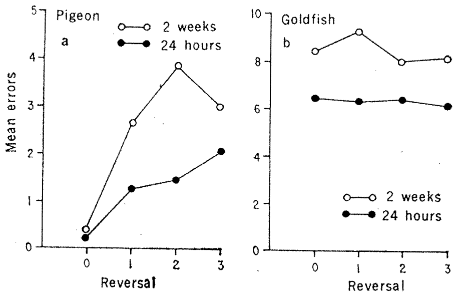

Fig. 1. Forgetting in the pigeon (a) and the goldfish (b) as a function of retention interval and number of prior problems. The results are plotted in terms of the mean number of errors made in the four tests at each retention interval.

In the pigeons, retention of the preference established in the original problem was almost perfect after 1 day and even after 2 weeks (Fig. 1a). In subsequent problems, with the animals trained to the same criterion as in the first, retention declined progressively and more rapidly at the long interval than at the short. A nonparametric analysis of variance (*5*) yields a significant effect of the number of problems ($P < .01$), a significant effect of the retention interval ($P < .05$), and a significant interaction between the two variables ($P < .05$). Clearly, retention in pigeons is adversely affected by prior training. In contrast, the curves for goldfish (Fig. 1b) give no indication of proactive interference. There was more forgetting in the goldfish after 2 weeks than after 1 day at all stages of training ($P < .01$), but there was no significant variation in retention with the number of prior problems and no interaction.

It should be noted that Kehoe (*6*) failed to find proactive interference in an earlier experiment with the pigeon. Although the present experimental design (with repeated tests in which each animal served as its own control) was developed in the anticipation that it would prove more sensitive than the conventional design used by Kehoe, it does permit a conventional analysis of the results, and that analysis, too, gives clear evidence of proactive interference.

The first two points in each of the curves of Fig. 1a represent the performance of independent groups of animals tested after the original problem or after a single reversal. In each case, there were significantly more errors in the R_1 test than in the R_0 test ($P < .01$). Whatever its explanation, the discrepancy between the new results for the pigeon and the earlier ones reminds us that further work might show proactive interference in the goldfish as well. Only after seeking the effect without success under a wide range of conditions can we be confident that it does not occur. On the assumption that proactive interference produces progressive improvement, we feel, however, that those efforts will be unsuccessful, because the fish fails to show progressive improvement under a wide range of conditions.

Our results suggest that different memory mechanisms operate in pigeons and goldfish. When a color preference is established and reversed in a pigeon, traces of the original training apparently remain after reversal training to interfere with the traces of that training and of subsequent training. Ablation experiments suggest that the hyperstriatum of the pigeon plays a part in the storage of these traces (*7*). After the reversal performance of a pigeon has been improved by training in a series of problems, injury to the hyperstriatum produces better retention of a preference established after operation and makes reversal difficult once more. One way to explain the fish results is to assume that, when a preference is reversed in a fish, the effects of the original training are not stored independently after reversal, but supplanted entirely by those of the reversal training. The progressive improvement in habit reversal which appears in the fish after enlargement of the optic tectum by transplantation (*8*) may be due to enhanced capacity for storage and the consequent opportunity for interference.

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Family Size and Sex-Role Stereotypes

Abstract. *Social attitudes about sex roles have been implicated as important factors in population growth. Degree of incorporation of stereotypic sex roles into the self-concepts of mothers is found to be related to completed family size.*

Rising concern about world overpopulation has focused interest on factors that influence family size. Initial optimism about the efficacy of the rapidly developing birth control technology has now become tempered by recognition of the possibility that social and psychological attitudes affecting the acceptance of the available methods may set limits to effective population control. A number of social factors related to family size have been previously identified and discussed, for example, socioeconomic class, education, and religion (*1*).

Davis (*2*) and Blake (*2*) have proposed that a critical psychological factor affecting the number of children a woman both desires and achieves is her acceptance or rejection of the feminine stereotypic social role prevalent in our society. Blake (*2*) has argued that most societies hold "pronatalistic" attitudes which prescribe for women the role of child-bearer and rearer. Acceptance of alternative feminine roles, such as employment in the work force, could reduce the social and intrapsychic pressure on women to produce children, and thus result in a smaller achieved family size. Several studies have reported that working women do indeed desire and have smaller families than nonworking women (*1, 3*). However, to our knowledge, no data exist on relationships between completed family size and the self-concepts of women with respect to alternative sex roles. The present study reports the finding that women who hold relatively masculine self-concepts have significantly smaller completed families than women who hold more stereotypically feminine self-concepts.

Ninety-six Catholic mothers of male college students completed a sex-role stereotype questionnaire. The construction and use of this instrument have been described in detail elsewhere (*4*). Briefly, it consists of 122 traits chosen by college students as discriminating between men and women. For each trait there is a bipolar horizontal scale, labeled at intervals with numbers, from "1" on the left to "7" on the right, with nine points between any two numbers. (On one such scale, for example, "1" would mean "not at all aggressive" and "7" would mean "very aggressive.") The responder can place a mark anywhere on the scale, under a variety of instructional conditions.

Each mother filled out the form three times: once as descriptive of adult men (masculinity response), once as descriptive of adult women (femininity response), and finally as descriptive of herself. Approximately half the mothers received "male" instructions first, while half received the "female" instructions first; "self" instructions were always given last so that the self ratings were always made within a masculinity-femininity context.

The male and female poles of each questionnaire item were defined by majority opinion of the mothers. Those items on which the consensus exceeded the .001 level of probability (at least 68 percent agreement) were termed "stereotypic." Fifty-seven items met this criterion.

Social desirability ratings for each item were obtained from a previous study (*4*) where 48 male and 39 female college-age students were asked to indicate the extent to which each trait would be desirable for a mature, healthy adult, sex unspecified.