Table 1. Mean weight (in grams) and survival time (in hours) for the rat and mouse as a function of infantile handling.

Days on which handled	Weight	Survival time	No. of animals
	Rat		
None	166.79	173.50	16
1 to 10	191.33	229.58	12
11 to 20	176.77	223.92	13
1 to 20	194.12	199.60	15
	Mouse		
None	17.14	90.47	17
1 to 10	18.81	95.00	10
11 to 20	19.22	90.31	16
1 to 20	19.87	72.83	12

second factor. This analysis permits the evaluation of the interaction between the two factors.

Weight. For both species a monotonic relationship is found between amount of handling in infancy and weight in later life. The animals handled for 20 days were the heaviest, while the controls were the lightest. Tests of significance showed that rats handled during the first 10 days of life (groups handled on days 1 to 10 and 1 to 20) weighed significantly more than the two groups not handled at this time ($P < .05$). The same finding was obtained with the mouse ($P < .01$). In addition, the presence of handling during the second 10 days of life also led to a significant increase in body weight for the mouse ($P < .01$). In neither species was the interaction significant ($F < 1.0$ in both analyses). We conclude, therefore, that for both species the effects of handling during the first and second 10 days of life affect later body weight in an additive manner, with the presence of handling during the first 10 days bringing about a significant weight gain.

Mortality. For both species a *non*-monotonic relationship is found between amount of handling in infancy and number of hours of survival in later life. For both the rat and mouse the interaction between presence or absence of handling during the first and second 10 days is significant beyond the .01 level. Inspection of Table 1 indicates that the reason for the significant interaction is that the animals which were handled on days 1 to 10 lived the longest, while those handled on days 1 to 20 died quite early. A test for trend, using the control group, the group handled on days 1 to 10, and the group handled on days 1 to 20, showed a significant quadratic (curvilinear) function beyond the .01 level for both species. We conclude, therefore, that handling during days 1 to 10 will lead to longer survival under total food and water deprivation but that lack of handling or prolonged handling will reduce survival time.

As one of us has reported elsewhere (*4*), the mouse data may be biased because of significantly differential "spontaneous" deaths which occurred between ages 28 and 35 days. That this is not a major bias is shown by a recent study by Levine and Cohen (*5*), who handled DBA/2 mice for the first 24 days of life and then injected leukemia virus into the experimental animals and nonhandled controls at about 50 days. They found that their handled mice died significantly earlier than the controls, which is consistent with our findings that the mice handled on days 1 to 20 died earlier than control mice. Our data for rats are also consistent with the findings of Levine and Otis (*6*), who reported a significantly lower proportion of deaths for rats handled for the first 20 days of life than for controls when both groups were placed on 120 hours of food and water deprivation.

Thus we see that when mice and rats are given 20 or more days of infantile handling the rats will survive longer than their controls while the reverse is true for the mice. It appears, therefore, that the same physical stimulation has a more severe effect upon the mouse. Though these two species differ in many respects, one of the outstanding differences between the C57BL/10Sc mouse and the albino rat is that the mouse is a more rapidly developing organism. This suggests the hypothesis that the more rapid an organism's development, the greater the effect of infantile experience. In addition to incorporating our data as well as the findings of Levine and Otis and Levine and Cohen, this hypothesis also accounts for the findings of King and Eleftheriou (*7*), who studied the effects of infantile stimulation upon two subspecies of the deer mouse, *Peromyscus maniculatus*. They found that *P. maniculatus bairdii,* a rapidly maturing organism, was deleteriously affected by the infantile stimulation, while *P. maniculatus gracilis,* a slowly maturing organism, was facilitated by the identical stimulation, as measured by behavioral tests of activity and learning, and by adrenal weights. Since a more rapidly maturing organism may have a shorter infantile period, the use of developmental indices such as eye opening may be a more appropriate basis for the administration of stimulation than the use of absolute age.

The mechanisms underlying these phenomena are as yet unknown. However, it is apparent that body weight is not related to survival time in any simple manner. It is also apparent that there is more similarity between the weight data for the rat and mouse than between the survival results. Denenberg has suggested (*4*) that the effect of infantile handling is to stress the organism, and this stress acts to reduce the animal's responsiveness to later stressing agents. The greater the magnitude or duration of the infantile stress, the greater is the reduction in responsiveness. The initial effect of reducing responsiveness to stress is to bring about a facilitation in performance (for example, through reducing emotionality), while prolongation of the infantile experience results in an organism which exhibits impaired performance. Within each species the present results are consistent with this hypothesis, but it is apparent that the age during which the organism is stimulated is another critical parameter. When making comparison across species, developmental rates, and probably other parameters, must be considered.

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Procedure for Studying Olfactory Discrimination in Pigeons

Abstract. A discrimination, based on olfactory stimuli, was established in two pigeons by an operant conditioning procedure. Results from control sessions demonstrate that the discrimination can be attributed only to the presence or absence of olfactory stimuli.

Experiments designed to determine whether birds possess a sense of smell have had equivocal results. Some workers have reported that birds are able to make precise olfactory discriminations, while others have found that birds fail completely in discriminating the presence of olfactory stimuli (*1*). Procedural difficulties and artifacts have marred the many experimental procedures that have been used by these workers. An experi-

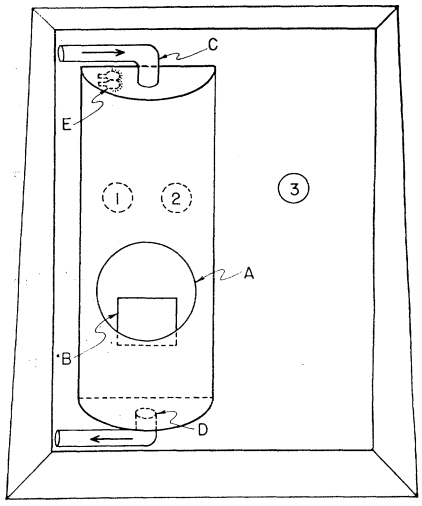

Fig. 1. View of front wall of the experimental chamber. All structures shown with broken lines are inside the cylinder. (See text.)

ment in which a standard training procedure is adapted for establishing discriminations based on olfactory stimuli (*2*) is described in this report.

The experimental chamber is a modified picnic icebox (*3*). Mounted on the left side of the front wall (see Fig. 1) is an aluminum cylinder with a circular opening *A,* which gives the bird access to two Plexiglas discs, Nos. 1 and 2 in the figure. These discs, here referred to as keys, are transilluminated by two 6-watt lamps, (key No. 1, with blue; key No. 2, with red) mounted behind the front wall. An opening *B* to a grain feeder is below these keys. A copper fitting *C* is mounted on the roof of the cylinder and is connected to a network of glass tubing through which a controlled stream of air can be passed. The apparatus used to deliver the olfactory stimulus is similar in type to that reported by Pfaffmann *et al.* (*4*), except that electric valves are used instead of stopcocks. A second copper fitting *D* is mounted on the floor of the cylinder and is connected to an exhaust pump that operates continuously during each experimental session. Two 6-watt lamps, *E,* illuminate the inside of the cylinder. A third key, No. 3, is mounted on the front wall outside the cylinder and is transilluminated by a yellow light. A 15-watt white lamp illuminates the chamber outside the cylinder. Four exhaust blowers are mounted on the walls of the chamber. The chamber and cylinder floors are covered with activated charcoal to trap lingering odors. A "white" masking noise is present throughout all sessions.

A trial begins with the illumination of both key No. 3 and the 15-watt lamp. A response (a peck) on this key initiates the flow of air into the cylinder through *C.* Nine seconds after this first peck, another peck turns off all the lights outside the cylinder and causes the interior of the cylinder to be illuminated. If the air stream is carrying an odor, the bird is rewarded with food for pecking seven times on key No. 1. Four pecks on key No. 2—that is, four incorrect responses—terminates the trial, and the pigeon receives no reward. If the air stream does not contain an odor, seven pecks on key No. 2 reward the animal with food, whereas four pecks on key No. 1 end the trial, without reward.

The odor and no-odor conditions are presented randomly from trial to trial, except that a correction procedure is always followed. When a trial terminates because the pigeon has made four pecks on the incorrect key, the same stimulus conditions are presented again during the next trial. The conditions may change only after seven pecks on the correct key have occurred in one trial. This procedure for changing the stimulus conditions prevents perseverative responding, which would otherwise reward responding on a single key 50 percent of the time.

Two male white Carneaux pigeons, maintained at 80 percent of their free-feeding body weights, undergo 50 trials in each session. Every trial, whether it ends in food reward or not, is followed by a 1-minute period when all lights are out. During this time, all exhaust fans operate and the odor-delivery system is cleaned.

Figure 2 shows the mean number of correct trials out of 50 for birds Nos. 264 and 263 under different conditions. Bar A shows the results for seven sessions in which sec-butyl acetate and distilled water were used as the odor and no-odor stimuli. The former has a strong odor and is also a trigeminal nerve irritant; it was used to maximize the likelihood that a discrimination would be established. After the discrimination had been established, a different odorant was used—isooctane, a substance with minimal irritating effects (*5*). Bar B shows the mean number of correct trials for 11 sessions in which isooctane was used as the stimulus.

Since there remains a possibility that some peculiarity of the delivery system, such as a difference in noise or pressure between the odor and the no-odor conditions, acted as a stimulus, a control session was set up for each bird. In the control session for bird No. 264, both the saturators in the delivery system were filled with distilled water. When air passed through the saturator that formerly contained isooctane, seven pecks by bird No. 264 on key No. 2 produced the food reward. For bird No. 263, both saturators were filled with isooctane. When air passed through the saturator that formerly contained distilled water, seven pecks on key No. 1 produced the food reward. No other procedural changes were made.

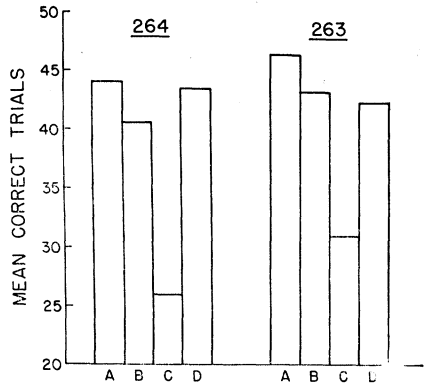

Fig. 2. Mean number of correct trials out of 50 trials for birds Nos. 264 and 263 under different experimental conditions. Bar A, trials with sec-butyl acetate (mean of seven sessions); bar B, trials with isooctane (mean of 11 sessions); bar C, control session; bar D, post-control sessions (mean of 32 sessions).

If the discrimination established with isooctane as the odorant was due to some artifact in the procedure, these changes would not have altered the number of correct trials during the control as opposed to previous experimental sessions.

The results of the control session (bar C) demonstrates that this is not the case. The fact that the performance drops far below the level maintained under the original conditions is evidence that pigeons can respond differentially to the presence or absence of an odorous substance. Following the control session, further trials were run with isooctane, under the conditions described above. Bar D, based on 32 sessions, shows that the mean number of correct trials returned to approximately the precontrol level for both birds.

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