Responses of infant monkeys to pictorial representations of a learned visual discrimination

ROBERT R. ZIMMERMAN, *University of Montana, Missoula, Mont. 59801*, and JULIAN HOCHBERG, *Columbia University, New York, N. Y. 10003*

Rhesus monkeys (5-150 days old) transferred learned discriminations between flat and solid objects (e.g., squares and cubes) to photographs and to systematically varied line drawings of these objects. The degree of transfer was inversely related to the degree of stimulus impoverishment. It was not possible in this experiment to differentiate between perceptual and learning variables.

At least one child who had never had associative experiences between objects and line drawings of objects correctly identified familiar objects portrayed by pictures and lines (Hochberg & Brooks, 1962). Extended research of this sort with human infants might provide approximate answers to the nature-nurture question in primate development of perception, but the experimental and social difficulties involved preclude systematic manipulation of environmental and developmental variables. The difficulties of using human infants in perceptual-development studies stand in sharp contrast to the convenience of using neonatal rhesus monkeys: (1) The visual system of the rhesus is, for all practical purposes, homologous to that of the human; (2) the rate of sensorimotor development is rapid; and (3) more is known about visual discrimination learning in the neonatal rhesus monkey than in any other primate. For these reasons, the experiments described below were undertaken to evaluate the ability of the infant monkey to transfer a previously learned response to photographs and perspective line drawings of the discriminanda.

GENERAL PROCEDURES

Discrimination learning and transfer tests were conducted in a modified Grice-type discrimination maze, 24 x 18 x 12 in. high. A starting box, 6 in. square, was separated from a choice chamber by a vertically sliding Plexiglas door. The choice chamber was 8 in. long and was separated from goal chambers by an opaque vertically sliding door. Both goal chambers were 9 in. wide and 10 in. deep and were separated by an opaque partition. All stimuli were mounted on boards that were inserted in the rear of the goal

chamber, and a hole was drilled in the center of each stimulus to permit the insertion of a nursing bottle nipple.

The Ss were trained to locomote from the start box to one of the goal chambers before discrimination training was begun. To avoid the development of position habits, the Ss were forced to go to each of the chambers an equal number of times by blocking one goal chamber with an opaque gray door. Training and testing were conducted five times a day at 2-h intervals, five trials per session. As reinforcement, the infants were permitted to drink approximately 5-10 cc of standard infant monkey milk formula per trial. On incorrect trials during discrimination training, the Ss were detained in the unrewarded goal chamber for approximately 15 sec.

Infants younger than 30 days of age received additional formula in their living cages at p.m. and 12 midnight. Animals 30 days and older were given fruit and monkey chow during the day. Water was available to the older animals at all times.

EXPERIMENT 1

Subjects

The Ss were three infant monkeys: one naive 5-day-old and two 120-day-old animals with extensive experience in planimetric discrimination problems.

Test Procedures

The Ss were trained to discriminate a square 3 in. on a side and a raised square 3 in. on a side and 5/8 in. deep. Both stimuli were painted with 1/4-in. black-and-white stripes aligned in a horizontal or vertical direction. The stimuli were mounted on 1/8-in. Masonite boards painted airplane gray and positioned at approximately 30 deg from the vertical plane.

After learning this discrimination to a criterion of 21 out of 25 correct responses for 2 consecutive days, the Ss received transfer of training tests to photographs of the stimuli that had been taken from the start box of the maze and enlarged to approximate the size of the original training stimuli. The pictorial stimuli were inserted vertically in the rear of the maze, but the perspective from the original task was maintained. Because of the distance involved in taking the photograph and the size of the enlargement, the pictures were slightly distorted and out of focus. The Ss were trained on the pictorial stimuli and the original training stimuli on alternate days until they achieved the

original criterion of learning on both. This procedure provided a control for potential emotional factors that might result as a function of a mere change in certain stimulus characteristics that would affect all measures of performance.

Results

On the initial problem, the 5-day-old animal required 18 days (450 trials) to achieve the criterion of learning, while the 120-day-old animals required 2 and 3 days (50 to 75 trials), respectively. In the transfer tests, the 5-day-old animal required 50 trials to achieve the same criterion and the two 120-day-old animals required 0 to 25 trials, respectively, to reach the same level of performance. Using the traditional measures of transfer of training, the 120-day-old animals showed 75% savings, on the average, in this transfer test. Assuming that maturational factors are operating in the case of the 5-day-old animal, it is difficult to evaluate the actual per cent savings. However, the fact that this animal was 25 days of age at the time of the transfer tests and that an animal of this age normally requires 150 to 200 trials to learn a simple pattern discrimination suggests that there was a high degree of transfer from the original objects to the photographs of these objects.

EXPERIMENT 2

Subjects

The eight Ss were the three Ss used in the previous experiment, one 5-day-old, two naive 20-day-old, and two 120-day-old monkeys. The 120-day-old Ss had had previous experience in reversal learning problems with the stimuli described in Experiment 1.

Test Procedures

The procedures were identical to those described in Experiment 1. The discriminanda used as the original learning problem in this experiment were similar to those described above, with the exception that the stripes were removed from the squares. Thus, the stimuli were a plain white square, 3 in. on a side and a 3-in. square block, 5/8 in. deep. Perspective line drawings of the stimuli for transfer tests were constructed by tracing the photographs from Experiment 1. Two aspects of the stimuli were altered systematically: (1) the presence or absence of a shadow at the base of the stereometric object, (2) the presence or absence of a contrasting background. Thus, four different pairs of line drawings were generated: (a) line drawings with a shadow on a gray background, (b) line drawings with no shadow on a gray background, (c) line drawings with a shadow on a white background, and (d) line drawings with no shadow on a white background.

The Ss from Experiment 1 were

reinforced for responses to the previously correct dimension (planimetric or stereometric), and the remaining Ss were assigned so that Ss with approximately equal past experience would form matched pairs. Thus, four Ss were reinforced for responses to the planimetric stimulus, and four Ss for responses to the stereometric stimulus. After achieving the criterion of learning, the Ss received five trials on each of the four line drawings and the original learning problem daily. The order of presentation of the stimuli was determined by assignment to randomized Latin squares and testing was continued until each stimulus had been presented a total of 50 times.

RESULTS

The Ss from the previous experiment transferred to the new stimuli with 100% savings, i.e., achieved the criterion of 21 out of 25 correct responses on the first day of training. The 120-day-old Ss with previous experience required 0 and 2 days, respectively; the 20-day-old naive Ss required 13 and 20 days of training, respectively, and the 5-day-old infant required 30 days of training to reach this level of performance.

In the transfer tests, all Ss maintained a high level of performance to the original learning problem, responding at a level of 98%-100% correct. Mean response for all Ss to outline figures over 50 trials was as follows: (A) shadow/gray background, 90%; (B) no shadow/gray background, 84%; (C) shadow/white background, 91%; (D) no shadow/white background, 70%. Under all conditions, the group scores show a progressive improvement in performance over the 50 trials, as measured in blocks of 10 trials. However, the change is only significant in the case of Stimulus D. Mean per cent correct responses to this stimulus in the first 10 trials was 56%, while mean per cent correct responses to the other three outline drawings did not go below 80%. A sign test indicated that the difference between Stimulus D and the other stimuli was significant at the .01 level. The reinforced dimensions, stereometric or planimetric, did not produce any consistent differences.

DISCUSSION

In both Experiment 1 and Experiment 2, the introduction of the new stimuli produced emotional responses in the Ss in the early trials. Typically, with the new stimuli, the Ss would sit and rock for long periods of time in the start box of the maze, then rapidly dash to a goal chamber and often refuse to drink the formula provided as reinforcement on correct trials. No animal showed significant negative transfer, and chance performance was typified by a return to a position habit

that was demonstrated in original learning.

The results of these two experiments indicate that the infant monkey is capable of making consistent responses to pictorial representation of stereometric stimuli, i.e., the young rhesus monkey responds to lines on paper in the same manner that it does to edges on objects. These studies also suggest that the presence of shadow on the stereometric object may be a sufficient condition to facilitate transfer, but that it is not a necessary condition since stimulus C (no shadow-gray background) resulted in significant transfer. It is also apparent that young monkeys rapidly learn to discriminate line drawings with no contrasting background and no shadows, since from the first block of 10 trials to the

last block of 10 trials, the per cent correct responses improves from 56% to 86% correct responses.

These preliminary studies do not, of course, evaluate the potential effects of stimulus change on performance, a factor known to produce a reduction of discrimination performance in young primates with limited experience. Before the perceptual aspects as measured by discrimination learning can be evaluated precisely, other performance factors must be taken into consideration.

REFERENCE

HOCHBERG, J., & BROOKS, V. Pictorial recognition as an unlearned ability: A study of one child's performance. *American Journal of Psychology*, 1962, 75, 624-628.

Comments on "An effect of yeast RNA on behavior" (Mountford & Heslip)

ARNOLD B. DAVIDSON and LEONARD COOK, *Smith Kline and French Laboratories, 1500 Spring Garden St., Philadelphia, Pa. 19101*

Mountford & Heslip (1969) reported valuable additional evidence of the task specificity of yeast RNA effects and data on its effect on food consumption and weight gain, all of which confirm our own findings (Cook & Davidson, 1968).

Their failure to find evidence of pathology after continued treatment with RNA is at variance with our data (Cook & Davidson, 1968), that extensive histo-pathological changes occurred following intraperitoneal treatment with 500 mg/kg/day of yeast RNA for 6 weeks. The difference may have been due to differences in dose, duration of treatment, or the possible presence of an impurity in our solution.

The reduction in food consumption and, by inference, in food motivation, need not

prevent demonstration of the facilitating effects of yeast RNA on performance maintained by food reinforcement, though it may indeed attenuate these effects. Yeast RNA aided acquisition of food-maintained discriminative behavior in a multiple FR-extinction schedule but not in a multiple VI-extinction schedule (Cook & Davidson, 1968). It appears that the task specificity of yeast RNA, evident in shock-maintained tasks, is also evident in food-maintained tasks.

REFERENCES

COOK, L., & DAVIDSON, A. B. Effects of yeast RNA and other pharmacological agents on acquisition, retention and performance in animals. In D. H. Efron (Ed.), *Psychopharmacology: A review of progress, 1957-1967*. Proceedings of the Sixth Annual Meeting of the American College of Neuropsychopharmacology (San Juan, 1967). Washington, D.C.: U.S. Government Printing Office, 1968. Pp. 931-946.

MOUNTFORD, D., & HESLIP, J. R. An effect of yeast RNA on behavior. *Psychonomic Science*, 1969, 16, 237-238.