DISCUSSION

The data indicate that the talapoin consumes a large quantity of water per kilogram of body weight compared to the squirrel monkey. The talapoins are also very active, manipulate objects frequently, and rapidly improve on a spontaneous learning task. The squirrel monkey is very inactive, does not manipulate objects, and did not learn the spontaneous learning task. These data suggest that the talapoin adapts readily to an experimental regimen, is responsive to the experimental environment and readily learns simple instrumental responses. It would appear to be an excellent alternative to *Saimiri*, particularly for tasks requiring a high level of behavioral responsiveness.

It is also of interest to compare the data on talapoins and squirrel monkeys to other data on the stumptail *(Macaca speciosa)* and rhesus *(Macaca mulatta)* monkeys obtained at the Delta Center.[2] The talapoin consumes 240 ml water/kg body weight, while the stumptail consumes approximately 180 ml/kg. The squirrel monkey consumes approximately the same amount of water as the rhesus (approximately 80 ml/kg). Although the experiments involved in the unpublished data differed somewhat in method from the present one, both the talapoins and stumptails had high rates of manipulation of objects and both rapidly increased to higher ratios on the spontaneous learning task. Furthermore, the talapoins are at least as high in manipulation and as proficient in the spontaneous learning task as the rhesus monkeys. These limited data available on different species of animals tentatively suggest that there may be high intraspecies correlations between seemingly diverse measures of general responsiveness.

REFERENCES

BITTERMAN, M. E. Phyletic differences in learning. American Psychologist, 1965, 20, 396-410.

COOPER, R. W., & KING, A. A. Availability and biomedical research utility of the talapoin monkey, *Cercopithecus (Miopithecus) talapoin.* Laboratory Primate Newsletter, 1968, 7, 4-8.

GLICKMAN, S. E., & SROGES, R. W. Curiosity in zoo animals. Behaviour, 1966, 26, 151-188.

MORRIS, D. The response of animals to a restricted environment. Symposium of the Zoological Society of London, 1964, 13, 99-118.

POLIDORA, V. J. Learning abilities of new world monkeys. American Journal of Physical Anthropology, 1964, 22, 245-252.

POVAR, M. L., & SALK, R. A device for measuring fluid intake by primates. Journal of the Experimental Analysis of Behavior, 1965, 8, 187-188.

ROSENBLUM, L. A., & COOPER, R. W. (Eds.), *The squirrel monkey.* New York: Academic Press, 1968.

SCHRIER, A. M., & POVAR, M. L. A note on the talapoin monkey, *Cercopithecus (Miopithecus) talapoin*, as a laboratory animal. Laboratory Primate Newsletter, 1968, 7, 9-11.

WINER, B. J. *Statistical principles in experimental design.* New York: McGraw-Hill, 1962.

NOTES

1. This work was supported in part by NIH Grant FR-00164 and by NIH Grant FR-00398-01 to Dr. T. H. Clewe.

2. C. E. Thomsen, Unpublished data.

The effects of early visual and motor experience on adult problem solving ability in hooded and albino rats[1]

ROBERT J. LAVALLEE,[2] University of Vermont, Burlington, Vt. 05401

The Hebb-Williams maze test was given in the light and in the dark to hooded and albino rats reared under various combinations of restricted environments, free environments, light and limited-light rearing conditions. When tested in the light, the free-environment rats were superior to the restricted ones. A significant interaction was also found in the light testing data between strain and light rearing conditions. In the dark, the hooded animals were inferior to the albinos.

The systematic study of the effects of early experience on adult problem-solving ability during the past 20 years has led to the generalization that an enriched early environment is associated with superior problem solving at maturity (Hebb, 1949; Hymovitch, 1952; Forgays & Forgays, 1952; Forgus, 1954, Forgays & Read, 1962). Exactly what an enriched early environment consists of is still not known. The recent literature in this area does suggest, however, that increased visual experience of some sort is an important factor in the enriched early-environment phenomenon.

The present study was undertaken to determine the effect of the visual contribution to the enriched-environment effect. To test the effect, two strains of rats were used: albino, which has a poor visual system, and hooded, which has a comparatively good visual system. The amount of light experience given the rats was varied to separate further the visual experience the animals received. Two testing sessions were given, one in the light followed by one in the dark, using the Hebb-Williams maze (Rabinovitch & Rosvold, 1951).

METHOD AND PROCEDURE

The Ss were 60 male and female rats (28 albino, 32 hooded) from the colony at the University of Vermont. A 2 by 2 by 2 factorial design, with the following variables, was used: (a) Free and restricted environment conditions—The free environments consisted of two 4 ft x 4 ft x 8 in. wire mesh cages, elevated 4 ft from the floor. The restricted environments were 16 9 x 15 in. laboratory cages (Forgays & Forgays, 1952). (b) Light and limited-light conditions—The light condition was a 7 x 9 ft room, illuminated 24 h a day; the limited-light condition was a similar room kept completely dark 23 h a day. Both rooms contained one free-environment cage and eight restricted-environment cages. (c) The third variable was animal strain—albino and hooded.

At 21 days of age, the rat pups were weaned and assigned, by the split-litter technique, to the various rearing conditions. The cages in the light and limited-light conditions were rotated over several positions once every week to counteract any positional effects. All Ss were on an ad lib food and water diet throughout rearing. Each animal was handled for 1 min each week in an attempt to acclimate him to handling and to reduce possible emotionality differences associated with differential isolation.

At 90 days of age, all animals were marked and put into 9 x 15 in. laboratory cages. Two days later, each animal was given two 5-min trials in a Hall-type (Hall, 1934) emotionality pen. Activity within the pen provided three separate scores: (1) total area covered, (2) distance penetration from the walls to the center of the 8-ft circular pen, and (3) a composite score made up of the first two by assigning weights to the various concentric circles and sectors of the pen. Defecations were also counted. On the day following the emotionality testing, the Ss were put on a 23-h food-deprivation schedule. On the following day, they began adaptation to the Hebb-Williams maze in the light.

One week following the completion of the light testing, the Ss were readapted to

Table 1
Means and Standard Deviations of the Error Scores for the Various Groups on the Hebb-Williams Test in the Light

		Albino	Hooded
Light Room Group	Free Environment	N: 6 M: 187.2 s: 38.8	N: 8 M: 168.1 s: 26.8
	Restricted Environment	N: 7 M: 206.6 s: 41.5	N: 8 M: 177.8 s: 28.9
Limited Light Room Group	Free Environment	N: 8 M: 180.8 s: 44.6	N: 9 M: 169.3 s: 36.3
	Restricted Environment	N: 8 M: 205.8 s: 49.9	N: 7 M: 207.0 s: 16.0

N: Number of subjects *M: Mean error score* *s: Standard deviation*

the maze, this time with the testing room completely darkened. The maze grid and the tops of the barriers were coated with fluorescent paint. A small loose-leaf-binder ring was also painted and placed around each rat's neck. The paint provided adequate cues for accurate observation of maze performance. Mirror image forms of the standardized maze problems were used for the dark running.

RESULTS

The data obtained from the emotionality testing revealed no significant differences in either defecation or activity among the various groups.

The mean error scores and their standard deviations for the various groups of Ss run on the Hebb-Williams maze test in the light are given in Table 1. Analysis of variance and a Duncan Multiple Range Test showed that the restricted animals made significantly more errors than the free-environment animals ($p < .05$). A significant interaction was also found in the light-running scores between animal strain and the light-rearing conditions ($p < .05$).

On the maze test run in the dark, analysis revealed only one significant difference: the hooded rats, over all conditions, made significantly more errors than the albinos ($p < .05$). Further analysis revealed no significant sex differences in either the light- or dark-running maze scores

DISCUSSION

Since no emotionality differences were found among the various groups, at least to the extent that activity and defecation measures reflect emotionality, it is felt that the differences found in the maze scores indicate actual differences in problem-solving ability.

The most interesting finding in this study is the interaction found in the light-testing scores between animal strain and the light or limited-light environmental conditions. In general, the albino rats were little affected by the restriction of their visual experience, but rearing them in restricted environments was associated with poor problem-solving ability. On the other hand, neither dark rearing nor a restricted environment alone had a significant effect on the performance of the hooded groups. Only when both factors were present was their maze performance poor. To generalize, as far as scores on the Hebb-Williams maze are concerned, one can, by the proper selection of rearing conditions, develop a hooded animal with typical albino problem-solving characteristics.

Under dark-testing conditions, the hooded rats made significantly more errors than the albinos, suggesting the greater dependence of hooded rats on visual cues. In comparing scores derived from testing in the light with those derived from testing in the dark, the albino group reared in the free environment, lighted room decreased its error score by 11% when running in the dark, while the rest of the albino groups decreased their errors by 25% or more. In short, the albino group most likely to be influenced by visual experience during rearing is the one most affected by changing the testing conditions from light to dark. For the hooded animals, the two groups reared largely in the dark decreased their error scores by 4%-8%, while the two groups reared in the light increased their errors by some 4% when running in the dark.

It appears that visual experience does contribute to the general enriched-environment phenomenon. It seems, however, that the importance of visual experience in early life will vary from strain to strain and species to species. It appears that an animal will make the best possible use of those cues which has at its disposal according to its physical capacities. The albino rat, because of its poor visual system, makes greater use of nonvisual cues than the hooded animal, as shown by the improved performance of the albino groups when running in the dark. The results also show that the free-environment albino rats and the free-environment hooded rats are superior to the restricted ones of their own strain, but for different reasons. The albinos seem to be using more nonvisual cues than the hooded, while the hooded depend more upon visual cues to solve the maze problems.

REFERENCES

FORGAYS, D. G., & FORGAYS, J. W. The nature of the effect of free-environmental experience in the rat. Journal of Comparative & Physiological Psychology, 1952, 45, 322-328.

FORGAYS, D. G., & READ, J. M. Crucial periods for free-environmental experience in the rat. Journal of Comparative & Physiological Psychology, 1962, 55, 816-818.

FORGUS, R. H. The effect of early perceptual learning on the behavioral organization of adult rats. Journal of Comparative & Physiological Psychology, 1954, 47, 331-336.

HEBB, D. O. *The organization of behavior.* New York: Wiley, 1949.

HYMOVITCH, B. The effects of experimental variations in early experience on problem solving in the rat. Journal of Comparative & Physiological Psychology, 1952, 45, 313-321.

RABINOVITCH, M. S., & ROSVOLD, R. E. A closed field intelligence test for rats. Canadian Journal of Psychology, 1951, 5, 122-128.

NOTES

1. The author wishes to thank Dr. D. G. Forgays for assistance and advice during the course of this research.

2. The author's present address is Medical Research Laboratory, U.S.A. Edgewood Arsenal, Edgewood, Md. 21010.