

Place learning in hippocampectomized rats*

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Six of 12 hippocampally lesioned, 6 of 12 amygdaloid lesioned, and 6 of 12 unoperated control rats were trained in place learning, and the remaining Ss were trained in response learning on an elevated cross-maze. Hippocampally lesioned rats were similar to amygdaloid lesioned and normal rats in days taken to reach criterion in response learning, but deficient in place learning. The mean number of errors/day to criterion on place and response learning for hippocampally lesioned rats was higher than it was for the control groups.

O'Keefe & Dostrovsky (1971) have suggested, on the basis of a study using single-unit recordings, that the hippocampus provides the rest of the brain with a spatial reference map of the environment. Hippocampal animals would, according to these authors, rely on simple S-R strategies rather than on a constellation of cues indicating spatial orientation.

It has been frequently reported that hippocampectomized animals are deficient on maze tasks in which accurate spatial orientation would benefit learning. Niki (1966), using a Dashiell maze, found that hippocampectomized animals showed less flexibility in path choice and made more errors than controls. Kimble (1963) & Hughes (1965) both found that hippocampectomized animals were deficient on problems in the Hebb-Williams mazes in that they tended to repeat errors. Kimble & Greene (1968) found a lack of latent learning in hippocampectomized rats that would suggest a deficit in the acquisition of a spatial map rather than specific responses.

The present experiment was designed, on the basis of Tolman et al's (1946) experiment, to determine whether hippocampectomized animals were deficient on a task that would be most simply learned by means of a cognitive map of the environment.

METHOD

Thirty-six male albino rats, weighing approximately 300 g, were employed as Ss. Twelve animals sustained bilateral RF lesions at three hippocampal levels: dorsal, intermediate, and ventral; 12 lesion control animals sustained lesions within the amygdaloid complex. Another 12 animals served as unoperated controls. All surgery was performed under clean conditions. The animals were anesthetized with pentobarbital sodium and positioned in a Stoelting 51200 stereotaxic instrument. Coordinates were determined from DeGroot (1959) and lesions produced by a Grass LM-3 lesion maker. Reconstruction of the most representative lesions for both lesion groups are shown in Fig. 1.

The apparatus is shown in Fig. 2. It was an elevated cross-maze painted black and with arms 48 in. long and 3.5 in.

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wide, with sunken food wells located 6 in. from the end of each arm and positioned on stands 30 in. high.

The apparatus was situated in a black-painted room and surrounded by four light-brown screens. While this reduced the number of spatial cues, there were various other objects in the room that were visible from the maze which could have been used as spatial cues.

Approximately 4-6 weeks after surgery, the animals were placed on a deprivation schedule and their body weights reduced to 85% and maintained at this level throughout the experiment. The animals were handled extensively through the initial stage of deprivation and then as a necessity during the training trials.

After the animals had reached criterion weight, pretraining began. On the first 2 days, each animal spent 5 min on the maze, adapting to the elevated position. For the next 4 days, each rat ate ground-nut pellets for 5 min at one of the four foodwells and was blocked off from exploring the maze by a removable Plexiglas barrier positioned 12 in. from the end of the arm. The foodwell from which the rat ate was varied from day to day at random, with the restriction that each rat ate from all four positions.

After pretraining, the lesion types were halved into two groups: the place-learning and the response-learning groups. The place-learning animals were assigned randomly to a foodwell

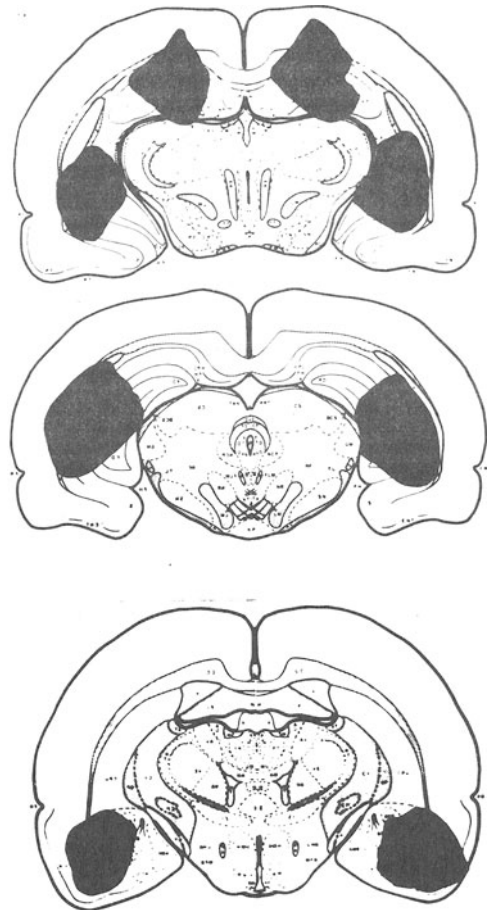


Fig. 1. Reconstruction of the most representative hippocampal and amygdaloid lesions.

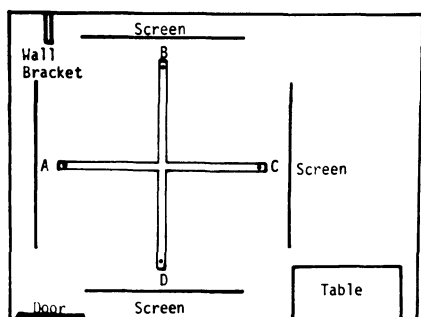


Fig. 2. Cross-maze in experimental environment.

RESULTS AND DISCUSSION

The means and standard deviations for days to criterion and errors/day to criterion for both place and response learning for all groups are shown in Table 1.

A Kruskal-Wallis one-way analysis of variance yielded a significant lesion effect for days to criterion ($p < .01$) on the place-learning task but not for the response-learning task. A similar analysis on errors produced a significant lesion effect on the place-learning ($p < .01$) but not on the response-learning task. It is clear that place learning and response learning are not isolated in the two tasks used in the present experiment. For example, in the first task (place learning), the animals had the opportunity for double-response learning, while in the second task (response learning), the animals had the opportunity for double-place learning. It can be argued, however, that if the animals were using response learning for both tasks, the animals should have taken longer to learn the first task, which is contrary to the evidence in the present experiment. If the animals had been using place learning to learn both tasks, then they should have learned the first task faster than the second, which is supported by the present experiment. It would appear, then, that while the evidence supports the idea that hippocampectomized animals are deficient in place learning, isolation of the two types of learning, as done by Hill & Thune (1952), would allow for a more specific interpretation. This is presently under investigation.

position that was loaded with a ground-nut pellet on every trial. The animal was started from the ends of adjacent arms. For example, if the animal was assigned to Foodwell A, the animal was started from D and B. The response-learning animals were assigned randomly to making a left or right turn at the choice point of the maze. They were also assigned at random to two starting positions on opposite arms. An adjacent foodwell was loaded with a ground-nut pellet depending on the starting position and turn that the rat was required to make. For example, if the rat was required to make a left turn, and was started from A and C, starting at A, Foodwell B was loaded.

Each animal received eight trials a day, with the starting position being determined randomly, with the restriction that four trials on a given day be from each of the two starting positions. Before the day's experimenting started, the maze was rotated randomly to ensure that no specific intramaze cues were being utilized. A correction method of maze learning was used. The number of errors on each trial and the number of days to criterion, which was eight correct responses on a single day, were recorded.

Table 1
Means and Standard Deviations for Days to Criterion and Errors/Day to Criterion for Hippocampal, Amygdaloid, and Normal Rats on Place and Response Learning

| | Place | | Response | |
|--------------------|-------|------|----------|-------|
| | Mean | SD | Mean | SD |
| Hippocampal | | | | |
| Errors | 6.94 | 1.54 | 8.56 | 2.15 |
| Days to Criterion | 13.67 | 3.27 | 20.00 | 11.78 |
| Amygdaloid | | | | |
| Errors | 5.89 | 1.83 | 6.45 | 1.13 |
| Days to Criterion | 6.50 | 2.40 | 21.17 | 13.11 |
| Normal | | | | |
| Errors | 3.86 | 0.69 | 6.75 | 1.27 |
| Days to Criterion | 6.00 | 3.42 | 21.50 | 13.47 |

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