CHAPTER IX
Experiment 8

The results of Experiments 5 and 6 indicated that both perceptual environmental stress and social environmental stress adversely affected the learning ability as well as the memory capacity of rats. Similarly, the results of Experiment 7 showed that both sensory deprivation stress and social isolation stress impaired depth perception of animals. Intellectual capacity or reasoning capacity is one of the cognitive abilities. The question, therefore, arises whether environmental stress (i.e., sensory deprivation stress and social isolation stress) retards the intelligence or reasoning capacity of the animals.

Hebb-Williams Maze test is a widely used test for measuring the intelligence or reasoning of rats. Hebb-Williams Maze scores were found to be correlated significantly with performance on the form discrimination and reversal learning task (Rajalakshmi & Jeeves, 1968). Since the results of Experiment 5 revealed that the environmental stress adversely affected the visual form discrimination learning abilities of the animals, it was hypothesized that the environmental stress would likely to impair animal's performance in the Hebb-Williams Maze test. The present experiment was, therefore, designed to find out the effects of environmental stress on the performance of rats in the Hebb-Williams Maze test. The present experiment involved a
2 x 2 factorial design having 10 rats per cell. These factors were two levels of perceptual environmental stress (perceptual enrichment/impoverishment) and two levels of social environmental stress (social enrichment/impoverishment).

Method

Subjects. *Rattus norvegicus var. albinus* (Wistar strain) males (*n* = 40), bred and raised in our laboratory, served as subjects. All these rats were the offspring of 10 mothers. The housing conditions, and the division of subjects into four equal groups, after weaning at an average age of 26 days (range = 25 - 29 days), were the same as described in Experiment 1.

Apparatus. The apparatus used in the present experiment was a Hebb-Williams Maze supplied by Techno Electronics, Lucknow (Serial No. 470071). The apparatus consisted of a box with an entrance alley and a food compartment at opposite corners of an open field. The box was mounted on four stands permitting the observer to sit and observe by the side of the apparatus at the time of testing.

The entrance alley (start box) and the food compartment (goal box) were both of 15.24 x 30.48 cm with a height of 13.0 cm. The open field was of 76.20 x 76.20 cm with a height of 13.0 cm. The floor and all the sides were painted bluish white. The floor of the open field was divided into 36 squares. The size of each square was 12.70 x 12.70 cm with
a thin black outlining. These served as markers for placing the barriers in each test, and also served to define error zones.

The barriers, used to construct the problems, were painted bluish white and were made from dressed lumber of 1.27 cm thickness of different sizes. They were constructed in such a way that set on edge, they reached exactly from the floor of the box to the screen top. They were made to the following specifications: 2 barriers, each of 12.70 cm in length; 4 barriers, each of 25.40 cm in length; 2 barriers, each of 38.10 cm in length; 2 barriers, each of 50.80 cm in length; and 1 barrier of 63.50 cm in length. A small piece of sheet metal, 5.08 x 1.27 cm, was nailed to the bottom of each barrier as a support to keep it standing on edge. A transparent thin glass sheet covered the apparatus.

Procedure. The design and the procedure of the present experiment in respect of assignment of animals into four rearing conditions, the nature of rearing environments, and the duration of differential rearing, were exactly the same as described in Experiment 1. Other details of the present experiment are given below.

From the 54th day of differential rearing, all the rats were subjected to a 23-hour food deprivation schedule till the completion of the test.
The entire procedure for Hebb-Williams Maze test was mainly divided into two sessions: (a) preliminary training, and (b) testing.

From the 61st day of differential rearing, each rat was given preliminary training in the Hebb-Williams Maze. The preliminary training was divided into three phases:

**First phase.** From the 61st day of differential rearing, the rats, two at a time, were put into the entrance box of the Hebb-Williams Maze for five minutes. Later, they were exposed to the maze field and were allowed to find their way to the food compartment (goal box). They were allowed to eat food in the goal box for a brief period of time after which they were given food outside the goal box on a table. In total, each rat was given 1 hour time for eating the food either inside or outside the goal box. However, it was never fed in his home cage. The rats were handled sufficiently before and after each session. This phase continued for 3 days.

**Second phase.** From the 64th treatment day of differential rearing, the rats of different treatment groups were given the practice problems A, B, C, D, E, F (Figure 15). The problems were created by putting barriers of different sizes at different places in the open field as indicated by solid lines in Figure 15. The length and number of barriers used for the practice problems are as follows:
Figure 15. Floor plan of training and test problems in Hebb-Williams Maze
Problem A was given in the 1st adaptation session, Problem B in the 2nd adaptive session, and so on until the series A to F was completed. The problems were changed serially from session to session. The series was repeated until the rats ran to the food compartment immediately upon being placed in the box. At no time was the same training problem used on succeeding occasions.

Third phase. From the 69th day of differential rearing, the rats were put into the maze individually with as much handling as possible. The same practice problem series (A to F) was again presented, one problem a day. Time was recorded from the moment the animal was placed in the entrance alley until it took its 1st bite of food in the goal box. When it reached the food, it was allowed to take a few bites and was then replaced in the entrance alley (starting box). Again it was allowed to go to the food being timed as previously.
The above process as repeated nine times a day until the animals reached the criterion of making 9 runs to food in a total of 60 seconds on two consecutive occasions. When an animal did not run as fast it should, it was given less total food and extra handling.

The rats were given 10 to 15 minutes to eat in the goal box and then were allowed to eat outside, but not in the home cage/room. Those rats, completing criterion earlier than the rest of the group, were still given training for four trials instead of nine trials to keep up the habit. All the rats reached the criterion (i.e., 9 runs in 60 seconds on two consecutive days) within eight days.

The purpose of the preliminary training was to train the rat to find food in the goal box, to adapt to the apparatus and to handling, and to establish a habit of eating in the food box. After much training, the animal would go to the food without fear and with a minimum of exploratory behaviour, in spite of changes in the position of the barriers.

The second session was the testing session. Figure 15 shows how to set up the test situations. The thin continuous crossed lines correspond to the lines painted on the floor of the apparatus. The dotted or broken lines mark the boundaries of error zones. The solid lines show the position of barriers.
From the 77th day of differential rearing, the testing session was started. In the testing session, the rats were given seven runs in the first problem situation and then were allowed to eat outside their living cages/room. Twenty-three hours later, the same procedure was repeated with the 2nd problem, and so on until all the 12 test problems were completed. No day was missed and all conditions were kept as constant as possible. The problems were created by placing different barriers of different sizes at different places of the open field as indicated by solid lines in Figure 15.

The dependent variable for each test problem was the total number of error zones entered by each rat. Time did not count. An error was scored each time when an animal’s forefeet crossed into an error zone. Each error zone was indicated by the dotted lines (see Figure 15). Where a blind alley contained two error zones (two dotted lines), two errors were scored if the animals crossed the second error line. However, no error was counted when it retraced from the blind alley through the first error zone. When an animal, having retraced from an error zone turned about and went back, a further error was scored. The total number of error zones entered by an animal in all the 12 test items was the final score for that animal which was taken account for analysis.
A ceiling fan was switched on to give a masking sound. The lighting condition and movement in the room were controlled as far as practicable. All testing was done between 7:30 a.m. to 5:30 p.m.

Results and Discussion

The mean body weights of four randomized groups, recorded just prior to they were subjected to different rearing conditions, were 47.0, 47.5, 46.5, and 46.0 grams. An analysis of variance performed on the body weights of the animals of four randomized groups revealed a nonsignificant group effect (see Table 30). In other words, the body weights vis-a-vis age of animals of four different randomized groups were kept under experimental control.

Table 30

Analysis of Variance performed on the Body Weights of Animals of Four Randomized Groups Prior to Treatment

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>3</td>
<td>4.17</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Within groups</td>
<td>36</td>
<td>57.92</td>
<td></td>
</tr>
</tbody>
</table>
An analysis of variance was performed on the total number of trials taken by each of the four groups of rats to reach the criterion (making 9 runs to food in a total of 60 seconds on two consecutive days). The results revealed significant perceptual environmental stress, and social environmental stress effects (see Table 31). No other effect was found to be statistically significant.

Table 31

Analysis of Variance performed on the Total Number of Trials taken by Subjects of Four Treatment Groups to reach the Criterion of Learning in the Hebb-Williams Maze Test

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Perceptual enrichment/impoverishment)</td>
<td>1</td>
<td>1904.4</td>
<td>68.573*</td>
</tr>
<tr>
<td>B (Social enrichment/impoverishment)</td>
<td>1</td>
<td>608.4</td>
<td>21.907*</td>
</tr>
<tr>
<td>A x B</td>
<td>1</td>
<td>52.9</td>
<td>1.905</td>
</tr>
<tr>
<td>Subjects within groups</td>
<td>36</td>
<td>27.77</td>
<td></td>
</tr>
</tbody>
</table>

* p < .01

The average number of trials taken by the animals reared in perceptually enriched and impoverished environments to reach the criterion of 9 runs in 60 seconds on two consecutive days, irrespective of social enrichment or
impoverishment, were 41.35 and 55.15, respectively. The group difference was found to be statistically significant. In other words, perceptual impoverishment was found to retard the rate of learning of the subjects, and thus, the PI animals took more trials than the PE animals to reach the criterion.

The average number of trials taken by the socially enriched and impoverished animals to reach the criterion, irrespective of perceptual enrichment or impoverishment, were 44.35 and 52.15, respectively. The group difference was found to be significant. In other words, the animals reared in social isolation took more trials than the animals reared in groups, and thus, social impoverishment was found to retard the rate of learning of rats.

Moreover, perceptual environmental stress was not found to interact significantly with social environmental stress in this measure. In other words, the rate of learning of four differential treatment groups was not different.

Increase of the number of trials signifies retardation of learning in Hebb-Williams Maze Test. The results, therefore, revealed that both perceptual impoverishment and social impoverishment retarded the rate of learning of rats.
An analysis of variance was performed on the total number of errors committed by the subjects of four treatment groups on the 12 test problems in the Hebb-Williams Maze test (see Table 32). The results revealed significant perceptual environmental stress* and social environmental stress effects. No other effect was found to be statistically significant.

Table 32

Analysis of Variance performed on the Total Number of Errors Committed by Subjects of Four Treatment Groups in the Hebb-Williams Maze Test

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Perceptual enrichment/impoverishment)</td>
<td>1</td>
<td>7635.836</td>
<td>40.143 *</td>
</tr>
<tr>
<td>B (Social enrichment/impoverishment)</td>
<td>1</td>
<td>6150.400</td>
<td>32.334 *</td>
</tr>
<tr>
<td>A x B</td>
<td>1</td>
<td>16.900</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Subjects within groups</td>
<td>36</td>
<td>190.217</td>
<td></td>
</tr>
</tbody>
</table>

*p < .01

The average number of errors committed by rats reared in perceptually enriched and impoverished environments, irrespective of social enrichment or impoverishment, were 148.85 and 240.35, respectively. The group difference was
found to be statistically significant. In other words, the PI animals made more errors, and thus, did worse in the Hebb-Williams Maze test than the PE animals.

The average number of errors made by animals reared in socially enriched and impoverished environments, irrespective of perceptual enrichment or impoverishment, were 182.2 and 207.0, respectively. This group difference was found to be statistically significant. In other words, the isolation-reared rats made more errors, and thus, were found to be worse performers in the Hebb-Williams Maze test than the group-reared rats. However, the perceptual environmental stress was not found to interact significantly with the social environmental stress in this measure.

Increase of errors in the Hebb-Williams Maze test signifies poor intelligence or lack of reasoning capacity. Both perceptual impoverishment and social impoverishment, therefore, were found to adversely affect the intellectual capacity or reasoning capacity of animals.