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Approach and consummatory behavior in rats with hippocampal lesions

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Approach and consummatory responses were measured in rats with hippocampal lesions. Compared to normal and neocortically damaged animals, rats with hippocampal lesions exhibited increased frequency of locomotor responses. These same animals, however, were identical to controls in consummatory responding. The results support the hypothesis of Murphy and Brown (1970), who suggested that hippocampal lesions may selectively release locomotor behavior in the rat.

Rats with lesions of the hippocampus are impaired on passive avoidance tasks (Isaacson & Wickelgren, 1962; Kimble, 1963; Kimura, 1958). These results are in agreement with studies on instrumental runway responses in which such animals are impaired when required to withhold a prepotent, or learned, motor response (Dalland, 1970; Franchina & Brown, 1970, 1971). However, rats with hippocampal ablations can withhold a prepotent consummatory response either as well as controls in a learned taste aversion (McGowan, Hankins, & Garcia, 1972; Murphy & Brown, 1974; Thomka & Brown, 1975) or even better than controls in a conditioned suppression test (Antelman & Brown, 1972). This dichotomy had been suggested earlier in the work of Murphy and Brown (1970). These authors proposed that hippocampal lesions in the rat may release certain behavior sequences, such as walking or running disproportionately to other classes of behavior. The present experiment examined this hypothesis of Murphy and Brown (1970) by measuring both the motor approach response to and the consummatory licking response of sucrose and quinine solutions in rats with lesions of the hippocampus. The hypothesis of Murphy and Brown (1970) would predict a higher frequency of approach responses on the part of the experimental animals, but not increased consumption. Moreover, the use of both sucrose and quinine solutions would allow for the detection of a possible Lesion by Palatability interaction.

METHOD

Subjects

The subjects were 24 male Sprague-Dawley rats that weighed 220-430 g at the beginning of the experiment. The animals were randomly divided into three groups of 8. One group (H) received bilateral ablations of the hippocampus. A second group (C) received neocortical control lesions. The third group (N) served as the normal control animals. All animals were housed in individual cages throughout the experiment, and testing was done in the subject's home cage.

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Surgery

Animals were anesthetized with sodium pentobarbital (Nembutal, 40 mg/kg) and placed in a headholder. The scalp was incised at the midline. A bilateral carniotomy was performed over the posterior neocortex between bregma and the lambdoid suture. For rats in Group H, the cortex overlying the hippocampus was first removed. The hippocampus was then aspirated under visual guidance as completely as possible. Group C animals had a similar amount of cortex removed, but the hippocampus was only visualized and not damaged. Surgery for Group N consisted of placing the animal in the headholder and incising the scalp, but not opening the skull. Behavioral testing began 2 weeks after the operation. Histological analysis revealed the lesions to be comparable to those recently published by Murphy and Brown (1974).

Testing Procedure

The subjects in this experiment had ad-lib access to food for the 2-week testing period, but fluid consumption was limited to only 15 min each day. During this 15-min period, the animals received sucrose (10% w/v) on Days 1-9, 11, and 13, and a quinine solution (0.25% w/v) on Days 10, 12, and 14. Days 1-6 were adaptation days. Data collection for both approach and consummatory responding began on Day 7. Consummatory behavior was defined as the amount of fluid the subjects drank in the 15-min test session. The motor behavior that was measured consisted of the number of approaches to the drinking tube. An approach response was scored whenever the animal came to the tube and began licking it. Before a second approach response could be scored, the animal had to stop drinking and change its bodily orientation away from the drinking spout. This could be either a movement of the entire body or a movement of the head to one side or the other.

RESULTS

Consummatory

Table 1 shows the means and standard deviations for the amount of sucrose and quinine consumed for all groups. The group means for sucrose ranged from 18.9 to 20.5 ml, and none of the between-group comparisons were significant, nor were there any reliable differences among the groups in the amount of quinine that was drunk. As indicated in Table 1, the range of group means for quinine was from 5.0 to 7.1 ml. As expected, quinine intake was significantly reduced in relation to sucrose intake. The mean reduction was highly significant for each group ($p < .001$).

Table 1
Consummatory Responding: Means and Standard Deviations (SD) for the Three Groups Across the Days of Sucrose and Quinine Consumption

Groups	Sucrose Mean	Sucrose SD	Quinine Mean	Quinine SD
Hippocampal	18.9	1.98	7.1	3.07
Neocortical	19.9	2.68	5.4	1.17
Normal	20.5	2.96	5.0	1.70

Motor Responses

Table 2 indicates the means and standard deviations for the number of approach responses to the sucrose and quinine solutions for the three groups. In contrast to the consummatory data, reliable between-group differences were found for the motor responses. The rats with hippocampal lesions made significantly more approach responses to the sucrose solution than either the normal group ($t = 3.92$, $df = 14$, $p < .001$, two-tailed t) or the cortical control group ($t = 3.21$, $df = 14$, $p < .01$). Examination of Table 2 also reveals that the variability of the group with hippocampal lesions was higher than that of the other two groups, due to the fact that the scores of two subjects with hippocampal lesions fell within the range of the normal group. The reason for this is not clear, since the scores were not correlated with the size of lesion. These latter groups were not significantly different from each other ($t = 1.69$, $df = 14$, $p > .05$).

Highly reliable differences in the number of approach responses occurred for all groups on the days that quinine was presented as the drinking fluid. For the group with hippocampal lesions, the mean increase from 11.0 to 24.8 was significant ($p < .004$). The cortical group increased its mean contacts from 4.8 to 14.5 ($p < .0001$), whereas the normal control group went from 3.4 to 11.6 ($p < .0001$). Though both control groups increased their approach responses relatively more than the group with hippocampal lesions, this group still made significantly more approaches than either the cortical group ($t = 2.22$, $df = 14$, $p < .05$) or the normal control group ($t = 2.88$, $df = 14$, $p < .05$). As in the sucrose condition, the group with cortical lesions and the normal group were not significantly different from each other ($t = 1.74$, $df = 14$, $p > .05$).

DISCUSSION

The results of this experiment indicate that rats with hippocampal lesions are identical to control animals in terms of the amount of intake for both sucrose and quinine solutions. These results may be due to a decrease in the duration of bouts of drinking and a simultaneous decrease in the interval between bouts. This would support the findings of Jarrard and Simsak (cited in Jarrard, 1973), who demonstrated that hippocampal lesions, while not affecting total consumption, did cause shorter duration of bouts of drinking, interrupted by a greater number of periods of alternative activity. The present results are also in agreement with the hypothesis of Murphy and Brown (1970), who suggested that one effect of a hippocampal lesion releases certain classes of behavior, such as walking or running, disproportionately to others. However, these same animals made significantly more approach responses to both the highly palatable sucrose solution and the relatively unpalatable quinine solution. Thus, the lesion effects were differential with respect to the class of behavior that was being measured. There was no evidence of any possible interaction between the effects of the lesion and the palatability of the solutions. The animals with hippocampal lesions were similar to the other groups in responding to the sucrose and quinine solutions. That is, all groups decreased the amount of quinine consumed and increased the number of approach responses to the quinine relative to their performance when receiving sucrose.

Thus, the main finding of the present experiment was the dissociation between the consummatory and motor responses on the part of the rats with hippocampal lesions. The present study shows this effect in that animals with hippocampal lesions made significantly more approach responses to a drinking tube but yet did not consume reliably more of either a sucrose or quinine solution. A similar dissociation between consummatory and motor responses was recently reported by Brown and Murphy (1973). These authors examined sucrose preferences in rats with hippocampal lesions under conditions of either food or water deprivation. Brown and Murphy (1973) found that, in a two-bottle test, rats with hippocampal lesions exhibited identical sucrose preferences when food-deprived, but that their preferences were altered when water deprived. However, under both deprivation conditions, these same animals made significantly more changes between the two-test solutions during the drinking session. The increased number of changes was an indication of the increased locomotor behavior of these animals, as is the

Table 2
Locomotor Responding: Means and Standard Deviations (SD) for the Three Groups Across the Days of Sucrose and Quinine Intake

Groups	Sucrose Mean	Sucrose SD	Quinine Mean	Quinine SD
Hippocampal	11.0	5.26	24.8	12.75
Neocortical	4.8	1.63	14.5	3.68
Normal	3.4	1.54	11.6	2.97
H vs. N	$p < .001$		$p < .05$	
H vs. C	$p < .01$		$p < .05$	
N vs. C	n.s.		n.s.	

increased number of approach responses made by the hippocampally damaged animals of the present experiment.

An interesting aspect of the present data is the behavior of the group with hippocampal lesions when drinking the sucrose solution. It should be recalled that these animals received fluids only during the 15-min test session, and that the sucrose solution was 10%, a very palatable solution for the rat. Why should the rat with a hippocampal ablation stop its drinking and move from the solution only to return shortly thereafter? Though both the present experiment and the study of Brown and Murphy (1973) show that the rat with a hippocampal lesion exhibits increased locomotor behavior, but no increased consummatory behavior, the studies do not provide clues as to whether the motor behavior is increased in all or only in some situations. Another recent paper, however, does shed some light on this aspect of the problem. Morey and Brown (Note 1) found that locomotor activity in rats with hippocampal lesions was increased only in the presence of positive incentive motivation stimuli. Such stimuli are typically found in studies examining the behavioral effects of hippocampal lesions. The fluids of the present experiment were such stimuli, even the quinine. Both fluids, though they differed in palatability, were the only means by which the animals could meet their hydrational needs.

REFERENCE NOTE

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