RESULTS

As shown in Fig. 1, when given no food Ss drank more saline than water in both single- and double-bottle tests. With food given Ss still drank more saline with a single bottle, but with double bottles they switched to water. For single-bottle data, analysis of variance shows a statistically significant difference ($p < .05$) for both food/no-food and saline/water comparisons. The slight nonparallelism between the saline and water curves (interaction) is not significant ($p > .05$). For the double-bottle data, analysis shows significant interaction effect with both main effects statistically not significant.

DISCUSSION

The results clearly show that the preference for isotonic saline (0.9%) depends upon the water need induced by dry-food ingestion. The saline curve and water curve with a single bottle are statistically parallel but, using the same Ss as their own control, Hsiao (1967)² showed a steeper increase in water intake from no-food to food conditions than the comparable increase in 0.9% saline or in 1.8% saline intake.

The preference change with double bottles cannot be due to adaptation to saline taste. In his unpublished data, Hsiao found that even in the first hour rats preferred water to saline when they ingested dry food.

Bare (1949), using a 24-h double-bottle test, showed that rats drink more hypotonic or isotonic saline solutions than water when food is available ad lib. However, about 10 cc of water is drunk by rats in addition to the saline solutions. Rats may drink more water while eating food but drink more saline when they are not eating.

Stricker & Wolf (1967) reported that even after injection of strong hypertonic saline rats drink more hypertonic saline than water in a double-bottle test. Comparing the results obtained by Deutsch & Jones (1960), Falk & Titlebaum (1963) and those cited above with the present results it should be noted that water is preferred to isotonic saline in a double-bottle test only when the rat is hungry and is taking dry food meal. Since rats eat less food when given 0.9% saline than water (Hsiao, 1967) they may have chosen water in order to eat more food.

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Fig. 1. One-hour intake of water or 0.9% saline solution in single- and double-bottle tests with or without food available in 24-h food/water-deprived rats.

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NOTES

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2. Also, Hsiao, S. Salted food and saline solutions intake by rats. Submitted to *Journal of Comparative & Physiological Psychology*, 1969.

Impaired acquisition of a successive visual pattern discrimination following hippocampal ablations in cats¹

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($p < 0.004$). Hence, ablation of the hippocampal region severely impairs the acquisition of successive discriminations in cats.

Three groups of mature cats were tested for acquisition of a successive visual pattern discrimination. Ammon's horn and pyriform cortex of Group 1 ($N = 6$) had been ablated. Group 2 ($N = 4$) were sham-operated and Group 3 ($N = 3$) were intact normal animals. Group 1 was significantly inferior to the combined control groups

The literature suggests that lesions of the hippocampal region produce postoperative acquisition deficits that are more severe for successive than for simultaneous problems. Kimble (1963) found that hippocampal rats were impaired on a successive, but not on a simultaneous, brightness discrimination. Stein & Kimble (1966) also found that hippocampectomized rats were not

impaired on the acquisition of a simultaneous brightness discrimination. Kimble and Stein's findings are also supported by those of Niki (1965) who found that hippocampal rats were impaired in the acquisition of a brightness discrimination in a continuously reinforced operant conditioning situation. Such a situation may be viewed as a successive brightness discrimination without an intertrial interval. In previous studies of cats, hippocampal lesions produced no deficits in the learning of simultaneous pattern discriminations (Teitelbaum, 1964; Webster & Voneida, 1964). The present study attempted to discover if lesions of the hippocampal region in the cat would produce deficits in the acquisition of a successive visual pattern discrimination.

METHODS

The acquisition of a successive visual pattern discrimination was compared in hippocampal, sham-operated, and normal cats. Thirteen adult cats were divided into three groups. The six Ss in Group 1 had bilateral hippocampal ablations; the four Ss in Group 2 had bilateral sham operations; three intact cats formed Group 3. No animals were trained on any pattern discrimination prior to surgery; however, all animals had learned auditory and brightness discriminations (Buerger, 1967). The apparatus and procedure in these auditory and brightness discriminations were identical to those described below except that a 300-Hz tone was substituted for the horizontal stimulus, and a lighted square was substituted for the vertical stimulus.

All surgery was performed in one step under pentobarbital anesthesia. The pyriform cortex, the ventral portions of Ammon's horn, and a small part (5-10 mm³) of the temporal region dorsolateral to the pyriform cortex were aspirated from Group 1. Only that same small part of the temporal region was removed from Group 2. Group 3 was unoperated. The surgical technique and the chamber used in this experiment have been described elsewhere (Buerger, 1967).

The Ss learned a successive visual pattern discrimination. The stimuli were three horizontal bars (H) or three vertical bars (V) of equal brightness presented randomly on a translucent tapping key for 6 sec. The Ss were fed condensed milk from a solenoid-driven dipper if the key was pressed when V was presented or if the key was not pressed when H was presented. The Ss were shocked through a floor grid if they pressed when H was presented or did not press when V was presented. There was a 3-sec rest period between consecutive stimuli. Each day, Ss were allowed 50 correct responses and as many errors as they required to reach this criterion. Ss were run every day until they

reached a criterion of six or less errors on 3 consecutive days. However, no S was run more than 40 days. All Ss were maintained at 80-85% of their ad lib weight by feeding them commercial cat food and/or vitamin pills. The Mann-Whitney test (Siegel, 1956) was used to evaluate the behavioral data.

All animals were sacrificed with pentobarbital and perfused with 10% formalin. Brains were cut into 3- to 5-mm blocks and photographed. Representative sections from these blocks were stained with Luxol fast blue, cresyl violet, and hematoxylin and eosine.³

RESULTS

The Ss in Group 1 showed no surgical damage to structures adjacent to the hippocampal region such as the thalamus and optic radiation. Group 2 showed no hippocampal lesions and Group 3 appeared normal. Dorsal portions of Ammon's horn were present in all of Group 1. Two Ss in Group 1 also had small segments of the anterior ventral tip of Ammon's horn remaining. However, in all cases this remnant was isolated from the dorsal portions. The pyriform cortex was removed from all of Group 1.

The Ss in Group 1 required 40+, 40+, 34, 22, 19, and 15 days to reach criterion. The Ss in Group 2 required 14, 11, 9, and 9 days, and the normal animals (Group 3) took 30, 8, and 5 days. The hippocampal Ss were significantly inferior to the combined control groups ($p < 0.004$). Also, Group 1 was impaired in comparison with the sham Ss ($p < 0.005$). However, the normal group was not significantly different from the hippocampal Ss ($p < 0.083$). This fact was clearly due to the normal S which took 30 days to reach criterion. Finally, the normal and sham groups were not significantly different ($p < 0.20$); the same normal animal mentioned above may be responsible also for the insignificance of this difference.

DISCUSSION

The results of this experiment clearly show that, in the cat, lesions of the ventral hippocampus (Ammon's horn) and/or pyriform cortex impair the acquisition of a successive visual discrimination. Hence, the cat and rat seem similar in this regard. It would be of interest to discover the reasons for the clear separation between the sham-operated and hippocampal groups. There are at least two general classes of explanation: anatomical and behavioral. The lesions in the experimental group included both pyriform cortex and ventral hippocampus. They are similar to the ablations which are reported to reduce the ability of neurosurgical patients to learn new information (Barbizet, 1963). It may be that production of a deficit in acquisition of discriminations by cats requires lesions of

both pyriform cortex and hippocampus. However, it is probable that the type of learning situation used in this experiment was a more important determinant. In addition to the reports cited in the introduction, Orbach, Milner, & Rasmussen (1960) found no evidence of impairment of simultaneous pattern and object discriminations in monkeys. Hence, the bulk of the evidence may indicate that ablations of the hippocampal region disrupt acquisition of successive discriminations more than simultaneous discriminations. It would be interesting to know if hippocampal lesions in other animals, such as monkeys, produce similar deficits on successive pattern discriminations.

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NOTES

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