Septal ablation and CAR acquisition in the golden hamster¹

E. S. MATAKA, WORCESTER FOUNDATION FOR EXPERIMENTAL BIOLOGY, Shrewsbury, Mass., AND B. N. BUNNELL, UNIVERSITY OF GEORGIA, Athens, Ga.

Bilateral septal lesions produced a significant improvement in the acquisition of a two-way active avoidance response in the hamster in comparison to the performance of operated controls and normal animals. A significant negative correlation was found between trials to criterion and intertrial spontaneous crossings for all groups combined. It appeared that normal hamsters have difficulty learning a two-way locomotor avoidance response.

Septal forebrain lesions produce a facilitation in the acquisition of conditioned active avoidance responses (CAR) when animals are trained in a two-way shuttle box. This result, first reported by King (1958) in the rat, has also been obtained in cat and monkey (e.g., Fox, Kimble, & Lickey, 1964; Buddington, King, & Roberts, 1967). In the present study the golden hamster, a rodent which does not show the septal rage syndrome commonly seen in the laboratory rat (Sodetz, Mataka, & Bunnell, 1967), was used to assess the effects of septal lesions on CAR acquisition.

Subjects. Twenty four male Syrian golden hamsters, obtained as weanlings from Manor Farms, were used. They were raised in group cages until one week before surgery was performed at which time they were transferred to individual cages. Ages ranged from six to eight months at the time of operation or equivalent control period. The animals were maintained on ad lib food and water; the diet consisted of Purina lab chow pellets, supplemented at regular intervals with greens and cereal grains.

Apparatus. The shuttle box was constructed of wood and painted flat black. Each of the two compartments, which were separated by a barrier 1 in. high, had its own shock grid; the barrier itself was provided with a shock grid to prevent Ss from perching on it. The interior dimensions of the box were 60 cm long, 20 cm wide, and 12.7 cm wide. A hinged Plexiglas lid covered each compartment. Shock (UCS) was provided by a constant current shock generator; the CS was a 12 V doorbell buzzer mounted on a control panel next to the shuttle box. A stopwatch was used to time both CS-UCS intervals and intertrial intervals. The apparatus was illuminated by a 60 W light bulb placed 60 cm above the center of the box.

Procedure. All surgery was performed under sodium pentobarbital anesthetic (90 mg/kg) and atropine sulphate was used to minimize respiratory complications. Bilateral RF lesions were placed using a stereotaxic instrument and lesion coordinates and parameters which had been determined empirically during a pilot study. Seven septal Ss completed testing. Five operated controls received bilateral lesions of the corpus callosum and adjacent cortex lying directly above the septal region. A normal control group of 12 Ss was also tested.

After allowing from three to seven days for postoperative recovery, avoidance training was begun. On the first day, the S was allowed 3 min to explore the shuttle box. It was then given three 10 sec presentations of the buzzer to make certain that it would not cross to the CS. A training trial consisted of a 10 sec presentation of the buzzer; if the S did not enter the adjacent compartment in this time, it was given a .6mA pulsed dc shock until it entered the appropriate compartment. Twenty trials per day were given, using a mean intertrial interval of 60 secs (range 30-90 secs), until the S reached a criterion of 8 avoidance responses in 10 trials, or until it became obvious that it was not going to learn the task. Testing was terminated after between 240 and 300 trials in such cases. A record was kept of the number of spontaneous crossings made by each S.

At the conclusion of testing, all operated Ss were sacrificed and standard histological procedures were used to reconstruct the lesions.²

Results and Discussion. The avoidance conditioning data are presented in Fig. 1 in terms of trials to criterion. Four of the

normals (N2, N4, N5, N6) and two of the operated controls (C2, C3) failed to reach criterion. All septals reached criterion in from 36 to 162 trials. Four of the normals (N7 through N10) and one operated control (C4) had scores that were well within the range of scores obtained from the septals. C4 had some bilateral destruction of the dorsal septum which might have accounted for its better performance. This could not have been the explanation for the differences between N1-N6 and N7-10, however. To check on the possibility that some inadvertent procedural change might have occurred in handling or testing the animals, two septals (S6 and S7) one operated control (C5) and two normals (N11 and N12) were run after the differences between N1-N6 and N7-N10 emerged. Although all three control animals reached criterion, their performance was markedly inferior to that of the two septals. It appears that the lesion effect is real.

Mann-Whitney U tests indicated that the septals were reliably different from both the normals ($n_1 = 7, n_2 = 12, U = 14, p < .02$, two-tailed) and operated controls ($n_1 = 5, n_2 = 7, U = 4, p < .03$, two-tailed). Normals and operated controls did not differ from each other on the trials to criterion measure.

King's (1958) finding that septal lesions produced enhanced active avoidance was also obtained by Kriekhaus, Simmons, Thomas, & Kenyon (1964). These investigators allowed septal hyperemotionality to disappear before training their rats, indicating that the improved performance was independent of the septal syndrome. The septal hamster never shows hyperirritability in response to human handling (Mataka et al, 1967) and it, like the rat, requires few trials to criterion on a two-way active avoidance task than do control Ss.

A significant rank-order correlation ($\rho = -.43, t = 2.22, p < .05$, $df = 22$) was obtained between trials to criterion and the number of spontaneous crossings made by each S. (The ranks for crossings included the spontaneous crossings made during the 3 min

Fig. 1. Trials to criterion for 7 septal, 5 operated control, and 12 normal hamsters. Ss C2, C3, N2, N4, N5, N6 failed to reach the criterion of 8 successful avoidance responses on 10 consecutive trials.

adaptation period given on the first day as well as intertrial crossings.) Analysis of the number of intertrial crossings on the first 40 trials showed that the septals made significantly more crossings than did the normals ($n_1 = 7$, $n_2 = 12$, $U = 14$, $p < .02$, two-tailed). The septal-control and normal-control differences were not significant, however. These results are in general agreement with the data of Schwartzbaum, Green, Beatty, & Thompson (1967) who found that septal rats made significantly more intertrial crossings than controls.

Although hamsters quickly learn an avoidance task which utilizes lever pressing (Pearl, 1963) or a jumping response Sandler & Karas, 1968), the majority of our normal and operated control animals had difficulty on two-way active avoidance and six out of 17 failed to reach criterion. Our data thus support and extend the findings of Babbini & Davis (1967) who have reported that hamsters are very inefficient in learning a one-way locomotor avoidance response.

REFERENCES

- BABBINI, M., & DAVIS, W. M. Active avoidance learning in hamsters. *Psychon. Sci.*, 1967, 9, 149-150.
- BUDDINGTON, R. W., KING, F. A., & ROBERTS, L. Emotionality and conditioned avoidance responding in the squirrel monkey following septal injury. *Psychon. Sci.*, 1967, 8, 195-196.

- FOX, S. S., KIMBLE, D. P., & LICKEY, M. E. Comparison of caudate nucleus and septal-area lesions on two types of avoidance behavior. *J. comp. physiol. Psychol.*, 1964, 58, 380-386.
- KING, F. A. Effects of septal and amygdaloid lesions on emotional behavior and conditioned avoidance responses in the rat. *J. nerv. ment. Dis.*, 1958, 126, 57-63.
- KRIECKHAUS, E. E., SIMMONS, H. J., THOMAS, G. J., & KENYON, J. Septal lesions enhance shock avoidance behavior in the rat. *Exp. Neurol.*, 1964, 9, 107-113.
- PEARL, J. Avoidance learning in rodents. *Psychol. Rep.*, 1963, 12, 139-145.
- SANDLER, B. E., & KARAS, G. G., Acquisition of a jumping avoidance response in hamsters. *Psychon. Sci.*, 1968, 10, 191-192.
- SCHWARTZBAUM, J. S., GREEN, R. H., BEATTY, W. W., & THOMPSON, J. B. Acquisition of avoidance behavior following septal lesions in the rat. *J. comp. physiol. Psychol.*, 1967, 63, 95-104.
- SODETZ, F. J., MATLKA, E. S., & BUNNELL, B. N. Septal ablation and affective behavior in the golden hamster. *Psychon. Sci.*, 1967, 7, 189-190.

NOTES

1. Supported by Grants NSF B-1149 and B-4604. The paper is based on a Masters thesis by E.S.M., University of Florida, December, 1964.
2. Copies of the lesion reconstructions may be obtained from E.S.M., Worcester Found. Exper. Biol., Shrewsbury, Mass. 01545