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BRIEF COMMUNICATION

Impairment of Hebb-Williams Maze Performance Following Prolonged Alcohol Consumption in Rats[1]

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BOND, N. W. AND E. L. DI GIUSTO. *Impairment of Hebb-Williams maze performance following prolonged alcohol consumption in rats.* PHARMAC. BIOCHEM. BEHAV. 5(1) 85–86, 1976. - Wistar rats consumed a liquid diet containing sustagen and ethanol for a period of 150 days. Control animals were pair-fed an identical diet except for isocaloric substitution of sucrose for ethanol. Forty-five days after the liquid diets were discontinued both groups were tested for performance on the Hebb-Williams maze. The experimental group made significantly more errors than the control group indicating that long-term ingestion of alcohol can lead to substantial impairment of problem-solving abilities in rats.

Chronic alcohol consumption Adequate nutrition Hebb-Williams maze Problem-solving ability

WHILE numerous studies have investigated the acute effects of alcohol intake on behavior, there has been little experimental research examining the possibility of enduring behavioral changes following long-term alcohol consumption. The relative absence of research on the behavioral effects of chronic alcohol ingestion has probably resulted from the fact that long-term administration of alcohol is practical only by the oral route, and the drug is aversive to animals even in low concentrations [3]. The likelihood of discovering enduring behavioral changes is suggested however, both by the frequent finding of brain damage and correlated psychological disturbances in alcoholics, and by a recent series of studies demonstrating impairment of shuttlebox avoidance acquisition by rats and mice and of timing behavior in rats following long-term alcohol consumption [2, 4, 8, 9]. These impairments were evident despite controls for nutritional deficiencies which can result from such long-term ingestion of the drug. More recently still, it was demonstrated that rats placed on a nutritious diet containing 35% ethanol-derived calories for only eight days, subsequently displayed marked changes in open-field behavior [1].

The function of the present experiment was to determine whether prolonged alcohol consumption, associated with adequate nutrition, could result in subsequent impairment of problem-solving performance on the Hebb-Williams maze in rats. If the experimentally demonstrated behavioral deficits in rodents can be explained in terms of short-term memory failures [10], then animals chronically ingesting alcohol should make significantly more errors on the Hebb-Williams maze, performance on which depends heavily on short-term memory functions [5]. The Hebb-Williams maze is a sensitive instrument capable of discriminating between brain-damaged and normal rats, cats and fish, between rats and cats reared in enriched and restricted environments, and between rats reared on protein-restricted and normal diets [11].

METHOD

Animals

Thirteen experimentally naive male Wistar rats were used. The animals were 100 days old and weighed 334–344 g when introduced to their special diets. Throughout the experiment the rats were maintained in a temperature-controlled room on a 12 hr light–dark cycle and were housed individually in wire cages measuring 15 x 24 x 20 cm.

Apparatus and Procedure

The animals were divided into 2 groups matched on weight. The 7 experimental rats received a liquid diet containing Sustagen and ethanol while the 6 control rats

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were pair-fed a liquid diet containing Sustagen and isocalorically substituted sucrose (c.f. [1]). The experimental diet contained 35% ethanol derived calories as described previously [1]. Both liquid diets were prepared daily and presented in 50 ml graduated Richter tubes inserted in the front of each cage.

All animals were maintained on their respective diets for 150 days. Following this interval the rats received dry food and water ad lib for 30 days, then were reduced to 80% of their free-feeding weights over a 15 day period in preparation for training and testing in the Hebb-Williams maze. Animals' weights were monitored throughout each of these phases of the experiment and at no stage did the mean weights of the experimental and control groups differ. In addition, switching from the liquid to the solid diet had no significant effect on the mean weights of either group.

The Hebb-Williams maze and the training and testing procedures employed in the present study are described in detail elsewhere [11]. Briefly, the procedure consisted of a 6 day period of handling and familiarization with the maze followed by 6 practice problems, 1 problem per day, 8 trials per problem. Following the 6 practice days all animals were able to complete their 8 daily trials in less than 5 min. On the next 12 days the rats were tested on 12 test problems, 1 problem per day, 8 trials per problem. Deprivation weights were maintained throughout training and testing, and reinforcement consisted of 5 Noyes food pellets per trial. Testing occurred between 9 a.m. and 12 p.m. each day.

The performance index consisted of the mean number of errors made by each animal on the 8 trials of each of the 12 test problems. Errors were scored as in Zimmermann and Wells [11].

RESULTS AND DISCUSSION

Inspection of Table 1 shows that the experimental group was inferior in performance to the control group on all but 2 of the 12 test problems. A 1-tailed Mann-Whitney U test between the groups showed that the experimental group made significantly more errors over all problems than the control group, which received the alcohol-free diet ($U = 5$, $p<0.01$). The present results indicate that long-term ingestion of alcohol can lead to substantial impairment of problem-solving abilities in rats. The decrement in performance was obtained despite the provision of an adequately nutritious diet, and despite the use of a pair-feeding technique which ensured that the experimental animals did not differ in body weight from the controls throughout the experiment.

TABLE 1

MEAN NUMBERS OF ERRORS MADE BY EACH GROUP ON EACH TEST PROBLEM

Test Problem Number	Experimental	Control
1	10.3	7.7
2	24.9	19.2
3	12.1	5.7
4	15.4	10.3
5	33.6	23.8
6	15.0	10.5
7	19.2	21.5
8	14.5	14.5
9	22.0	14.0
10	8.9	6.7
11	8.3	5.1
12	14.7	13.8
Total Errors	198.9	152.8

The apparent behavioral toxicity of long-term alcohol intake has now been reliably demonstrated in infra-human animals on a variety of experimental tasks, and it is interesting to speculate as to what mechanisms may be mediating the various performance deficits. The hypothesis that short-term memory functions of animals are impaired by alcohol in an analogous fashion to Korsakoff's syndrome in humans [10] is consistent with much of the available data. However, the possibility of a perceptual malfunction cannot be discounted. For example, chronic alcohol intake has been shown to markedly reduce olfactory acuity in humans [6], and olfaction can be an important determinant of discrimination learning in rats [7]. The possibility arises therefore that the variety of alcohol-induced behavioral deficits which have been obtained in rodents are due to an impairment of olfactory acuity in these animals. This hypothesis will need to be tested before it is possible to state with any confidence that an animal model of the Korsakoff memory syndrome has been developed.

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