Effect of Lead Acetate on Memory in Mice

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Introduction

Lead poisoning is a major problem in certain urban areas where children living in dilapidated housing can ingest peeling paint, plaster and putty containing lead (CHISOLM 1971). Excessive intake of lead in young children may result in irreversible damage to the central nervous system, and cause permanent mental retardation (CHISOLM 1965). In addition to children, another high-risk group is found in industry where workers exposed to supposedly "safe" levels of lead may develop subclinical neuropathy (SEPPÄLÄINEN et al. 1975). The fact that environmental contamination by lead represents a serious public health problem has prompted a number of animal studies using behavioural techniques. For example, suckling rats nursed by lead-treated dams exhibited learning impairment when tested at age 8 to 10 weeks (BROWN 1975), and lambs prenatally exposed to lead also showed slowed learning (CARSON et al. 1974). Sublethal exposure of adult mice to lead acetate caused motor disability and impairment of learning (OGILVIE 1977).

Since lead exposure can interfere with learning, it seems reasonable to suggest that it might also impair memory. In two studies with rats tested in a water T-maze, neither lead tetraethyl (BULLOCK et al. 1966) nor lead acetate (BROWN et al. 1971) had any effects on memory. In both of these studies lead was administered prior to the completion of training. When mice were exposed to DDT either before training in a T-maze, or just prior to retraining one month later, there were only marginal effects on memory in contrast to a marked effect produced when the animals were injected with DDT immediately after training (CRAIG 1972). According to HEBB (1949), the period immediately following training is critical for certain processes related to the consolidation of learning. Thus, the sooner rats were treated with anaesthetics or convulsive agents within one hour of having performed a task, the more deleterious was the effect on a repeat performance of the same task (PEARLMAN 1961). In view of these facts, the aim of the experiment described in this paper was to determine if a sublethal dose of lead acetate administered to mice immediately after maze training could interfere with memory.

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Methods

Male CF-1 albino mice ranging in weight from 31 to 44 g were used for this study. Immediately after reaching criterion in a water T-maze, each animal was given an i.p. injection of 100 mg/kg of lead acetate dissolved in double-distilled water, or distilled water only. Two weeks later the animals were retested in the maze. Each animal was identified by an ear punch so that its performance during retraining could be compared with its original response to the maze during the first series of trials.

The T-maze was constructed of white plexiglass. The stem of the T was 10 cm wide and 30 cm long, and the section forming the arms measured 10 cm by 50 cm. The walls were 8 cm high, and the maze was filled with water to a depth of about 5 cm. Escape from the maze required that the animal swim approximately 50 cm to a ladder (wire screen) located at the end of the left arm of the T. Escape time was measured with a stopwatch. If an animal failed to reach the ladder after 60 sec it was removed, and the time for that trial was recorded as 60 sec. Each animal was given a one-minute rest between trials. In addition to escape time, the other parameters tested in this study included errors to criterion, and trials to criterion. An error was defined as a turn back to the point of entry into the maze, a right turn instead of a left at the junction of the stem and the arms of the maze, or a turn away from the escape ladder once it was approached. An animal was said to have reached criterion when it made seven consecutive trials without an error.

Results and Discussion

The dose of lead acetate used in this study was approximately 38% of the two-week LD50 value determined in an earlier preliminary investigation (OGILVIE, unpublished results), and for the present study this dose resulted in no mortality. Moreover, the lead-treated animals appeared to be in good health, and exhibited no overt signs of neurotoxicity.

Examination of the performance data for training and retraining (Table 1) reveals that the control mice required significantly fewer trials to reach criterion during retraining than during the first series of maze trials ($P<0.01$) and in addition, they made significantly fewer errors ($P<0.05$). Similarly, lead-treated mice also required significantly fewer trials to reach criterion during retraining than during training ($P<0.02$), and like the control mice, they also made significantly fewer errors during retraining ($P<0.01$).

The escape (swimming) time data are presented in Fig. 1 and once again, it can be seen that there was an obvious improvement during retraining, and the improvement was approximately equal for both control and lead-treated mice.

TABLE 1

Performance of albino mice in a water T-maze during training and retraining two weeks later. The mice were injected with lead acetate (100 mg/kg) or distilled water (control) immediately after training.

Group	Parameter	Training	Retraining	P
Control (N=8)	Trials to criterion	12.3 ± 1.6[+]	7.1 ± 0.1	<0.01
	Errors to criterion	3.1 ± 0.6	1.4 ± 0.3	<0.05
Lead (N=10)	Trials to criterion	13.7 ± 1.2	9.2 ± 0.7	<0.02
	Errors to criterion	4.3 ± 0.6	1.4 ± 0.3	<0.01

[+]Mean ± 1 standard error

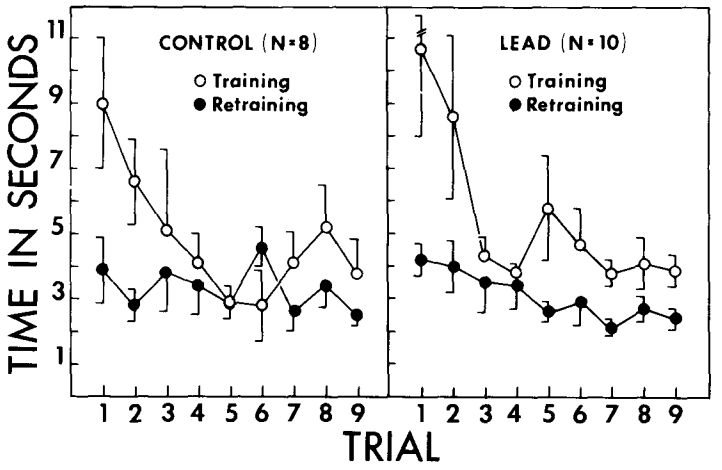

Fig. 1. Mean escape times during the first nine trials of training and retraining for albino mice tested in a water T-maze. The retraining trials were conducted two weeks after training, and the animals were injected with distilled water (control) or lead acetate (100 mg/kg) immediately after the first series of maze trials.

These results indicate that although the dose of lead acetate used in this study was both relatively high, and administered at a critical time as far as consolidation of learning is concerned, it had no observable effects on memory as determined by three different testing parameters. This finding therefore confirms the previous reports by BULLOCK (1966) and BROWN et al. (1971) in which lead administered prior to the completion of training also had no effect on memory. Thus, despite the fact that there is now good evidence that lead impairs the mechanism of information storage, it appears that this environmental contaminant does not affect the retrieval of stored information.

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