The Effects of X-irradiation on the Rat Behavior

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ABSTRACT

Conditioned aversion to saccharin solution was demonstrated by whole-body irradiation at doses of more than 25 R in 100-day-old Wistar rats. The degree of aversion depended on radiation dose and the duration of this effect depended on the age of the irradiated rats. The repeated conditioning produced the same degree of aversion as in the first conditioning. The sugar solution had no effect as a conditioning stimulus.

INTRODUCTION

It has been demonstrated by Garcia et al. that ionizing radiation of 30 R or 57 R dose is effective in inducing a conditioned aversion to a preferred saccharin solution in the rats of Sprague-Dawley strain. Garcia et al. have also showed that the avoidance behavior could be produced by the use of neutron radiation at total doses of as low as 10 rads. Furthermore, there have been three reports on saccharin avoidance conditioning produced by X-irradiation in Wistar rats: 120–150 day-old, irradiated with 102 R by McLaurin et al.; 90–150 day-old, irradiated with 295.8 R by Scarborough et al.; 500–day-old, irradiated with 50–350 R by Smith et al.. From these investigations, it is apparent that the saccharin avoidance behavior can be produced by radiation of relatively low dose level.

According to Garcia et al. saccharin aversion lasted for several weeks after a single dose of 30 R. However, no report has been published on the second conditioning after the rats have recovered from previous saccharin avoidance conditioning.

The use of 0.8% NaCl has been demonstrated to be effective in causing ionizing

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radiation to act as an unconditioning stimulus in rat behavior (Perry\textsuperscript{3}). Therefore, a question arose as to whether avoidance behavior could be produced with a stimulus other than saccharin, such as sugar flavored water.

The purpose of the present study is to test: (1) Whether saccharin avoidance behavior can be produced by relatively low-dose irradiation in young Wistar rats. (2) Whether saccharin avoidance behavior can be produced in the rats recovered from the previous radiation effects by exposing them to radiation again. (3) Whether avoidance behavior can be produced by sugar flavored water as in the case of saccharin solution.

MATERIALS AND METHODS

Young male Wistar rats, aged 100 days at the beginning of the experiments, were used as material. Each rat was individually housed.

After a deprivation of water for 23 hours, all rats, were subjected to habituation trials, where they were given 20 minutes of free access to a water bottle, followed by 3 minutes of sham-irradiation. On the next day, after 23 hours of water deprivation, a bottle containing 0.1% saccharin solution was attached to each cage for 20 minutes prior to X-irradiation or sham-irradiation. It was noted that all rats drank saccharin solution during this session. The rats were randomly divided into experimental and control groups of 10 animals each.

The rats were confined in a plastic chamber and placed under an X-ray machine. The group assigned to irradiation was irradiated at 180 kVp, 25 mA, 1.0 mm Cu + 0.5 mm Al filters, 16.3 R/min dose rate, 80 cm target distance. The group assigned to sham-irradiation was subjected to experimental procedures identical to those of the irradiated rats, except that the X-ray machine was operated with closed shutter. After receiving an appropriate dose, the rats were removed from the chamber and returned to the home cages. Two bottles were then attached to each cage, one containing tap water and the other 0.1% saccharin fluid, so that a preference test between water and saccharin solution could be started immediately after irradiation. The bottles were removed at an interval of 24 hours, and the consumption of both the water and saccharin solution was measured by weighing the bottles. The bottles were alternated daily from the left to the right side of the cage in order to decrease the possibility of establishing a place preference. Saccharin preference score used as the criterion of avoidance behavior was represented by the ratio in percentage of the consumption of saccharin solution to the consumption of total fluid per 24 hours or 48 hours.

RESULTS AND DISCUSSION

Fig. 1 shows the effects of X-irradiation on saccharin preference in young male Wistar rats. No avoidance behavior can be detected by whole-body 10 R irradiation. It can be seen that saccharin avoidance behavior can be obtained by whole-body irradiation of doses of more than 25 R as in Spraque-Dawley rats, and that the
degree of this radiation effect depends on radiation dose. Smith et al.\(^5\) reported saccharin aversion as determined by preference test during 24-48 hours after radiation exposure, indicating that an increase in the roentgen doses from 50 R to 350 R have no effect on the 500-day-old rats. Results obtained in the present study also indicated that no pronounced effect due to the increase was produced at the doses from 50 R to 100 R within 48 hours after irradiation.

It is apparent from Fig. 1 that the saccharin aversion decreased gradually after the irradiation. In order to examine the saccharin avoidance behavior of the rats that have completely recovered from the effect of the previous irradiation, the following experiments have been carried out. After having confirmed the extinction of saccharin aversion, bottle containing saccharin solution was removed from each cage, the water bottle being left as before for a week. In the second irradiation, the same dose as that of the first irradiation was given. As shown in Fig. 2, the saccharin preference in the reirradiated rats was reduced in the same degree.
Fig. 2. The change in saccharin preference score after the first and the second X-irradiation of 50 R.

as in the case of the first irradiation. It can also be seen that the duration of saccharin avoidance behavior after the second irradiation was reduced to about half that observed after the first irradiation. However, it remains to be clarified whether the reduction of duration of radiation-induced response is caused by the repeated conditioning or the age of the rats. To confirm this point, the rats of the same age (100 days), were divided into two groups, the one subjected to the conditioning irradiation of 50 R and the other to the sham-irradiation. After keeping the animals for one month under the usual feeding, they were exposed to the second conditioning irradiation of 50 R.

Fig. 3 shows that there is little difference in saccharin avoidance behavior between the two groups irrespective of the previous conditioning irradiation. Thus, we conclude that the duration of the radiation-induced saccharin aversion is not affected by the repeated irradiation, but is dependent on the age of rats.

Fig. 4 shows the effect of radiation on sugar preference of the rats. Instead of saccharin, sugar solutions of the various concentrations were used as a conditioning stimulus, since these sugar solutions had been found by preliminary experiment to be greatly preferred by the rats (more than 90% in preference score). Under the present experimental conditions, we failed to demonstrate the effectiveness of sugar solution as a conditioning stimulus in rat behavior. Further
The effects of X-irradiation on saccharin avoidance behavior in 130-day-old rats with and without the previous conditioning irradiation.

experiments as to whether this different effectiveness between saccharin and sugar is due to the difference in the taste discrimination between saccharin and sugar. will be reported later.

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Fig. 4. The group mean of sugar preference scores after 100 R irradiation, sugar solutions of the various concentrations being given as a conditioning stimulus prior to irradiation. Black and white bars represent the mean sugar preference scores in the sham-irradiated and X-irradiated rats, respectively.

REFERENCES