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THE EFFECTS OF 15,000 RADS PULSED GAMMA-NEUTRON RADIATION ON THE BEHAVIORAL PERFORMANCE OF MONKEYS (MACACA MULATTA)

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Defense Atomic Support Agency
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THE EFFECTS OF 15,000 RADS PULSED GAMMA-NEUTRON RADIATION ON THE BEHAVIORAL PERFORMANCE OF MONKEYS (MACACA MULATTA)

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ABSTRACT

Seven male monkeys trained to a visual discrimination task were exposed to a pulsed 15,000-rad midline tissue dose of gamma-neutron radiation. Of these seven animals, five were unable to perform within 5 minutes postirradiation and remained in a state of total nonperformance until death. The two remaining animals experienced periods of severe performance decrement followed by a return of performance capability which approached the preirradiation value. This performance capability deteriorated rapidly at 58 and 88 minutes postirradiation in these two animals, after which time the subjects failed to perform until death. The median survival time for all animals was 1 hour and 18 minutes.

I. INTRODUCTION

The literature contains a number of investigations concerning the effects of pulsed gamma-neutron irradiation on the conditioned behavior of monkeys.[1,3-9] A majority of these studies are concerned with doses of 10,000 rads or less and information concerning the ability of monkeys to perform a learned task following a higher radiation exposure is quite limited. In order to provide information currently required by the Army* this study to determine the performance capabilities of the monkey following exposure to 15,000 rads of pulsed radiation was conducted.

II. PROCEDURE

Seven male monkeys (Macaca mulatta) weighing from 4.2 to 5.2 kg were used. The animals were maintained in primate chairs and housed in individual isolation cubicles.

The apparatus and training procedures employed have been described in a previous report.[2] The behavioral task was a shock motivated simultaneous visual discrimination. Trials were presented every 10 seconds with each trial being initiated by the simultaneous illumination of two response keys and a 15-watt house light. The animals had 5 seconds in which to respond to the correct key. If the subject failed to respond within the 5-second period or responded to the incorrect stimulus the house light remained on, the stimuli extinguished, a tone was initiated and a brief shock was delivered. If the animal responded correctly the house light and stimuli were extinguished for the remainder of the 10-second trial interval. Trials were presented

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* Personal communication, Dr. Charles Davidson, U. S. Army Combat Developments Command, Institute of Nuclear Studies, Fort Bliss, El Paso, Texas 79916

in blocks of 100 and each block was followed by a 3-minute rest period. A block of trials and the following rest period lasted 20 minutes.

Each animal was trained using successive approximation techniques until a criterion of 90 percent correct responses for 600 trials was reached. At this point a base-line test approximating exposure conditions was conducted.

Two to three days after the base-line test the animals were placed in Exposure Room No. 2 of the AFRRI-TRIGA reactor for the radiation exposure. The animals were positioned where previous dose mapping indicated a midline tissue dose (MTD) of 15,000 rads would be received. Dose determinations were obtained by measuring the tissue kerma, free-in-air, and multiplying this value by an experimentally derived factor of 0.85.

Behavioral testing started with a block of 100 trials prior to the exposure. The irradiation exposure occurred simultaneously with the onset of the second block of trials and testing continued for 2 hours (a total of 600 trials). Following this 2-hour period the animals were removed from the exposure room and were subsequently tested at 1-hour intervals until death.

III. RESULTS

The radiation dose and the survival time for each animal are presented in Table I. These data indicate that the survival times ranged from 34 minutes to 3 hours and 20 minutes postirradiation. The average MTD was 15,300 rads with less than a 3 percent variation among animals.

The performance data for the seven animals are presented in Figure 1. These data indicate that only two of the subjects were capable of performing the task at the

criterion level after the first 5 minutes postirradiation. The performance accuracy for all animals showed an immediate decline after exposure, however, two subjects regained their ability to perform after demonstrating a period of severe performance decrement. The duration of the decrement was approximately 2 and 30 minutes respectively for animals Nos. 179 and 202. The plateau or recovery phase following these decrements lasted approximately 84 minutes for animal No. 179 and approximately 26 minutes for animal No. 202. During this period the performance of both animals approached the base-line level of efficiency. The recovery phase deteriorated rapidly into a period of total nonperformance which terminated in death of the subjects.

Clinical observations were made of all animals during the postirradiation period. The symptoms observed included apparently random movement of the head and limbs, nystagmus, pupillary dilatation, vocalization and body movements in response to the electrical shock. Vomiting was observed in only one animal, No. 181. The gross symptomology was similar for all animals and nothing was observed which has not been previously reported for monkeys exposed to supralethal doses of radiation.

Animal #	Tissue kerma free-in-air (rads)	Midline tissue dose (rads)	Survival time
172	17,882	15,200	1 h, 20 min
179	18,000	15,300	2 h, 20 min
181	18,117	15,400	52 min
182	18,117	15,400	34 min
183	18,000	15,300	1 h, 12 min
202	17,882	15,200	3 h, 20 min
204	17,647	15,000	1 h, 18 min

Table I. Dose and Survival Time

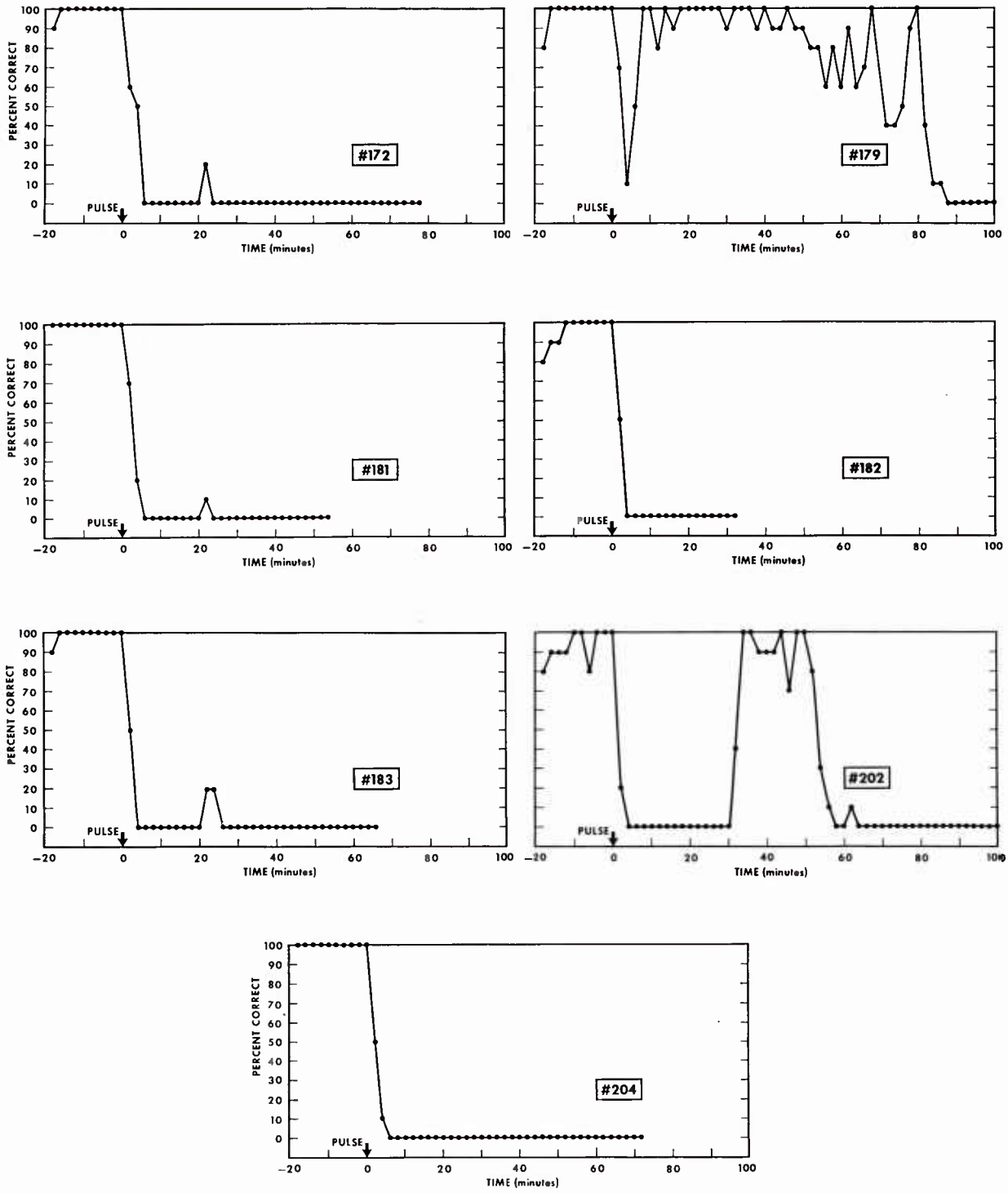

Figure 1. Percent correct performance postirradiation. During each 20-minute interval, 100 trials and a 3-minute rest period were presented. Each point on the graph is the average of 10 trials.

IV. DISCUSSION

Germas et al.,[5] reported that following exposure to 10,000 rads of gamma-neutron radiation, monkeys, trained to a similar behavioral paradigm, were capable of accurate task performance as long as 24 hours postirradiation. Of the six animals reported by Germas et al., a total loss of performance capability immediately after exposure was observed for only one. The remaining five animals demonstrated periods of severe performance decrement following which their performance returned to near the preirradiation value. The median time of final performance for these animals was 6.4 hours. In comparison, of the seven animals used in the present study five were unable to perform the learned task within 5 minutes postirradiation and all subjects were incapable of performance within 88 minutes postirradiation.

These data indicate that a total loss of performance capability will be experienced by a large percentage of monkeys immediately following an exposure to a pulsed 15,000-rad MTD of radiation. The data further suggest that the total population will be incapable of completing an assigned task within 2 hours after exposure to a radiation dose of this magnitude.

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13. ABSTRACT

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