EFFECTS OF ^{28}SI RADIATION ON NEUROBEHAVIORAL FUNCTION

Catherine M. Davis[1], Peter G. Roma[2, 1], Peter M. Guida[3], & Robert D. Hienz[1, 2]
Johns Hopkins University School of Medicine, Baltimore, MD, USA[1]
Institutes for Behavior Resources, Baltimore, MD, USA[2]
Brookhaven National Laboratory, Upton, NY, USA[3]

INTRODUCTION

To approximate human neurobehavioral risk assessments from exposure to space radiation, performance data were obtained with the rPVT (rat Psychomotor Vigilance Test), an animal analog of the human PVT test currently employed in a variety of operational settings to assess human neurobehavioral function. The human PVT was developed as a highly sensitive and standardized assay capable of quantifying temporally dynamic changes in sustained attention and circadian rhythm, and requires responding to a light stimulus as soon as it appears; a response extinguishes the stimulus and displays the reaction time to the stimulus. Simple to perform, the PVT is widely used in human risk assessments and has been recently developed and adopted for use on the ISS as a “self test” to provide feedback on crew neurobehavioral performance capacity (e.g., changes in alertness, fatigue).

METHODS

The rPVT tracks the same general performance variables as the human PVT (e.g., motor function, speed, inhibitory control or “impulsivity”, selective attention). Cohorts of adult male rats were trained on the rPVT, exported to BNL for head-only radiation exposure (0, 10, 25, and 50 cGy ^{28}Si ions, 300 MeV/n), and then returned to Johns Hopkins for follow-up testing.

RESULTS

Prior results have shown that exposure to either protons (25, 50, 100, and 200 cGy, 150 MeV/n) or ^{56}Fe ions (10, 25, and 50 cGy, 600 MeV/n) produces highly specific effects on vigilance that include impairments in accuracy (decreased percent correct scores and increased false alarm rates) and impulsivity (i.e., increased premature responding). Further, subjects have shown differential susceptibilities to proton and ^{56}Fe radiation exposures in that definable subsets of irradiated animals show strong neurobehavioral deficits (i.e., appear to be "radiation sensitive"). Additionally, the magnitude of the effects in radiation-sensitive animals can be independent of dose for both protons and ^{56}Fe (i.e., 10 cGy produced neurobehavioral effects similar to those observed at 25 and 50 cGy). The present report describes the detailed effects of ^{28}Si on neurobehavioral function and includes descriptions of deficits in performance accuracy, attention, impulsivity, and motor function (speed of reaction times). Similarities and differences following exposure to between ^{28}Si, proton, and ^{56}Fe radiation will be compared and contrasted.

The neurobehavioral deficits following low-dose irradiation suggest that such radiation-induced impairments could significantly impact routine performances in operational environments during long-duration exploratory missions, and also negatively affect post-mission adjustment upon return to Earth. Additionally, these data suggest that a differential susceptibility may exist for individuals exposed to radiation, and that some forms of radiation may be more damaging for CNS function than others (e.g., ^{56}Fe-induced deficits being greater than ^{28}Si–induced deficits) under certain conditions.

Supported by NSBRI through NASA NCC 9-58-NBPF02802 and PF02602