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Reduced Set-Shifting Processing Speed in Male Rats Following Exposure to Low (10 cGy) Doses of Proton Radiation

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Space radiation (SR) exposure poses a threat to astronaut health, including the central nervous system, during long-duration space missions. Previous animal studies have demonstrated a range of cognitive impairments following exposure to mission-relevant doses (<25 cGy) of various energetic SR particles. One such impairment involves SR-induced attenuation of attentional set-shifting ability, a key function in decision-making that enables the selection of relevant features. However, the impact of the most abundant SR component—protons—on attentional set-shifting performance remains unexplored.

Accordingly, we evaluated attentional set-shifting performance in rats exposed to low (10 cGy) doses of 100 MeV/n protons (LET = ~0.6 keV/μm), both alone and in combination with hypergravity. Our findings indicate that exposure to 10 cGy protons, either alone or in combination with hypergravity, significantly impaired attentional set-shifting performance. Specifically, proton exposure resulted in a higher mean correct latency (MCL), which is a measure of the processing speed during set-shifting tasks. No significant difference was observed between the performance of rats exposed to protons alone versus those exposed to protons and hypergravity.

Overall, our findings show the effect of proton exposure on the ability of rats to inhibit habitual responses and learn new response-outcome contingencies. Our results are consistent with findings in medulloblastoma patients exposed to proton therapy, who exhibit a similar significant loss of processing speed. The operational significance of the SR-induced loss of processing speed needs to be further determined. However, should similar effects be induced in astronauts exposed to galactic cosmic rays, these data suggest a reduced ability to execute tasks when dealing with complex situations.

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