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The Effects of Extremely Low Geomagnetic Field Intensity on the Mammalian Central Nervous System

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Accumulating evidence has shown that exposure to an extremely low magnetic field (hypomagnetic field, HMF, <5 μT) for extended periods has detrimental effects on the function of multiple systems in animals. In the adult mammalian brain, neural stem cells are present in the subventriclular zone and the dentate gyrus. These cells continually generate new neurons, which support learning and memory. This process of adult neurogenesis is highly sensitive to external environmental stimuli. We have experimentally revealed that, after long-term exposure to HMF, mice showed defective adult neurogenesis and cognitive dysfunction. Mechanistically, HMF exposure directly inhibits adult neurogenesis by suppressing mitochondrial oxidative phosphorylation and reducing the levels of endogenous reactive oxygen species (ROS) in neural stem cells. Additionally, HMF exposure increases the global ROS levels in the hippocampus. This ROS increase triggers oxidative stress and activates downstream inflammatory pathways, ultimately leading to chronic neuroinflammation. These findings indicate the essential role of the ambient geomagnetic field (GMF) in maintaining adult neurogenesis and cognitive function in mice and provide valuable hints for assessing the potential risks extremely weak magnetic field exposure in future manned deep-space missions.