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Behavioural and Cognitive Risk Characterization

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ABSTRACT

Given the requirement of employing animal subjects for radiation testing, a coordinated set of measures to evaluate both people and animals must be devised in order to facilitate the translation and harmonisation of animal research data to the astronaut corps. The determination of scaling factors or transfer functions that can be used to relate human and animal outcomes will be necessary for the identification of POLs and PELs for each of the spaceflight stressors (e.g., space radiation, altered gravity, isolation and confinement, sleep disruption) separately and in combination.

KEYWORDS: Behavioural Measures, Cognitive Risk, Space Flight, Neuroscience, Model Stressors.

BEHAVIORAL AND COGNITIVE RISK

The potential effects of spaceflight risks on cognitive and behavioural performance must be taken into account while managing crew health for lengthy missions (Clément et al. 2020). In order to define the risk of unfavourable cognitive or behavioural problems that might influence crew health and performance during spaceflight, both human and animal research is employed. This is because spaceflight has a unique environment. There are two reasons why crew cognitive and behavioural health and performance require translational techniques. To determine if radiation experiment results apply to the astronaut corps, animal data must first be translated to the human scale. (Insel et al. 2010; Kern et al. 2011; Williams et al. 2020) Homologous behavioural tests in animals and humans have been identified and evaluated for their capacity to predict effects of drugs, emulate features of neurological disease, engage corresponding brain regions and circuits, and engage corresponding physiological mechanisms. Many are currently being used for the evaluation of radiation and other spaceflight stressors (such as psychomotor vigilance) (Kiffer, Boerma, and Allen 2019). The concept validity might be evaluated independently by combining behavioural testing with complementing functional imaging and electrophysiological methods. Second, a solid strategy must be devised to evaluate all spaceflight risks and comprehend the full effects of spaceflight. The definition of permissible outcome levels (POLs), which specify allowed levels of decrement for measurements that correspond to outcomes important to either in-mission performance or long-term health, is pertinent to both difficulties (Anon 2007). In order to assess performance and give triggers for starting mitigation efforts, outcome indicators that can be reliably monitored are required by the definition of POLs. Once POLs have been created, experimental investigations can examine the individual and combined environmental permissible exposure levels (PELs) that correspond to the stated POLs. Over 1,125 operational activities and subtasks have been identified for a reference trip to Mars and connected to relevant cognitive, affective, and social behavioural domains (Stuster et al. 2018). (Roma and Schorn 2020). These component domains can be evaluated by direct observation or using quantitative behavioural test batteries that examine substitute outcome measures (for example, the "Cognition" battery) (Basner et al. 2015). To evaluate changes in several of these domains directly in people, surrogate exposures for flight dangers such head-down bedrest, sleep disturbance, and extended confinement and isolation in ground-based institutions can be used. However, describing the effects of space-like radiation exposure depends on animal experiments that is informed by human epidemiological data from the cohorts of people who were occupationally exposed to radiation, had radiation therapy, or survived an atomic bomb. To identify scaling factors or transfer functions for spaceflight exposure profiles, a coordinated set of data for humans and animals is currently urgently needed. The Department of Transportation, for instance, uses periods of disturbed sleep to find exposure levels in people that cause unacceptable cognitive impairment in airline pilots, railway engineers, and truck drivers (Hursh et al. 2006). By comparing conventional effect size ratings, such as Z-scores (Aho 2013), animal cognitive performance in equivalent tests following sleep disruption may likewise be measured and matched to human performance. Based on sleep as the stressor, the link between human exposure-responses and animal homolog exposure-responses may serve as a scaling factor or transfer function for other spaceflight-related exposure types that cannot be evaluated in humans. Equivalent to the damage caused by sleep disturbance, animals can be subjected to radiation that is similar to that seen in space according to the NASA Space Radiation Laboratory (Simonsen et al., 2020). A PEL for radiation in animals to humans at the POL and similar operational impairment level may be extrapolated by mapping the animal radiation-to-sleep relations and the animal-to-human sleep relations for the homologous outcome measures, as shown in Figure 2.

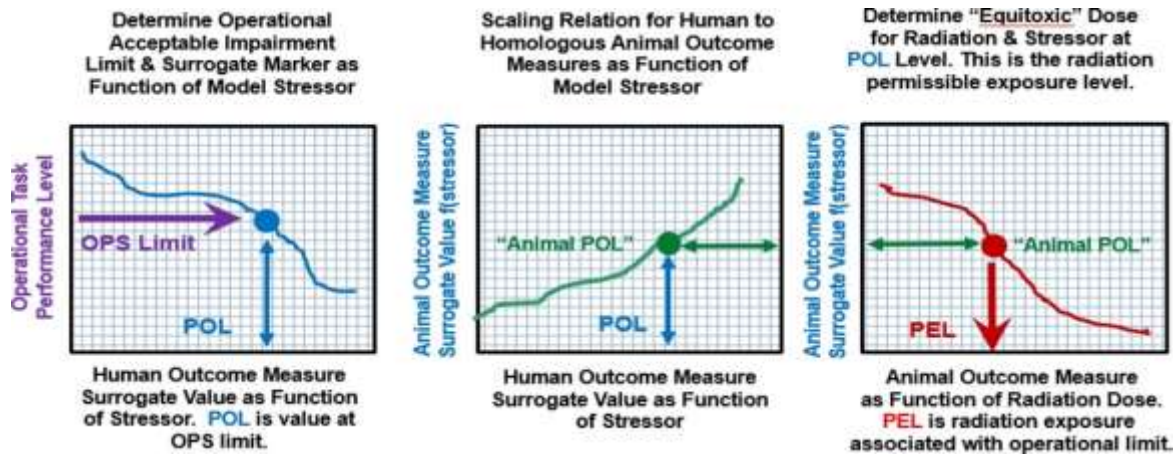

Figure 2 shows the relationship between effect size and exposure levels when POLs and PELs are determined using animal intermediates, surrogate measurements, or biomarkers. [4]

By extension, utilising animal response intermediates, additional stressors that are compatible with humans can have effects that are related to similar radiation exposure levels. Following the establishment of individual stressor PELs, combined stressor exposure regimens may be utilised to calculate exposure limits for various mission situations.

References.

1. Aho, Ken A. 2013. Foundational and Applied Statistics for Biologists Using R. 1st edition. Boca Raton, Florida: Chapman and Hall/CRC. Anon. 2007. "NASA SPACE FLIGHT HUMAN SYSTEM STANDARD VOLUME 1: CREW HEALTH."
2. Anon. n.d. "Report No. 183 – Radiation Exposure in Space and the Potential for Central Nervous System Effects: Phase II (2019) - NCRP | Bethesda, MD." Retrieved October 15, 2021 (https://ncrponline.org/shop/reports/report-no-183-radiation-exposure-in-space-and- the-potential-for-central-nervous-system-effects-phase-ii-2019/).
3. Basner, Mathias, Adam Savitt, Tyler M. Moore, Allison M. Port, Sarah McGuire, Adrian J. Ecker, Jad Nasrini, Daniel J. Mollicone, Christopher M. Mott, Thom McCann, David F. Dinges, and Ruben C. Gur. 2015. "Development and Validation of the Cognition Test Battery for Spaceflight." Aerospace Medicine and Human Performance 86(11):942–52. doi: 10.3357/AMHP.4343.2015.
4. Clément, Gilles R., Richard D. Boyle, Kerry A. George, Gregory A. Nelson, Millard F. Reschke, Thomas J. Williams, and William H. Paloski. 2020. "Challenges to the Central Nervous System during Human Spaceflight Missions to Mars." Journal of Neurophysiology 123(5):2037–63. doi: 10.1152/jn.00476.2019.
5. Hursh, Steven R., Thomas G. Raslear, A. Scott Kaye, and Joseph F. Fanzone. 2006. "Validation and Calibration of a Fatigue Assessment Tool for Railroad Work Schedules, Summary Report: (736302011-001)."
6. Insel, Thomas, Bruce Cuthbert, Marjorie Garvey, Robert Heinssen, Daniel S. Pine, Kevin Quinn, Charles Sanislow, and Philip Wang. 2010. "Research Domain Criteria (RDoC): Toward a New Classification Framework for Research on Mental Disorders." The American Journal of Psychiatry 167(7):748–51. doi: 10.1176/appi.ajp.2010.09091379.
7. Kern, Robert S., James M. Gold, Dwight Dickinson, Michael F. Green, Keith H. Nuechterlein, Lyle E. Baade, Richard S. E. Keefe, Raquelle I. Mesholam-Gately, Larry J. Seidman, Cathy Lee, Catherine A. Sugar, and Stephen R. Marder. 2011. "The MCCB Impairment Profile for Schizophrenia Outpatients: Results from the MATRICS Psychometric and Standardization Study." Schizophrenia Research 126(1):124–31. doi: 10.1016/j.schres.2010.11.008.
8. Kiffer, Frederico, Marjan Boerma, and Antiño Allen. 2019. "Behavioral Effects of Space Radiation: A Comprehensive Review of Animal Studies." Life Sciences in Space Research 21:1–21. doi: 10.1016/j.lssr.2019.02.004.
9. Roma, Peter G., and J. Schorn. 2020."Assessment of Central Nervous System / Behavioral Medicine / Sensorimotor (CBS) Operational Performance Measures." Presented at the NASA Human Research Program Investigators' Workshop, January, Galveston,TX.
10. Simonsen, Lisa C., Tony C. Slaba, Peter Guida, and Adam Rusek. 2020. "NASA's First Ground- Based Galactic Cosmic Ray Simulator: Enabling a New Era in Space Radiobiology Research." PLOS Biology 18(5):e3000669. doi: 10.1371/journal.pbio.3000669.
11. Stuster, Jack W., Jurine A. Adolf, Vicky E. Byrne, and Maya Greene. 2018. Human Exploration of Mars: Preliminary Lists of Crew Tasks. NASA/CR-2018-220043.
12. Williams, Thomas, Ajitkumar Mulavara, Gregory Nelson, B. yates, and Catherine M. Davis. 2020. Summary Report for the Technical Interchange Meeting: Nasa Translational Working Group Focused on Synergistic Effects of Central Nervous System, Behavioral Medicine, and Sensorimotor Risks. NASA technical publication. NASA/TP.