



Sensorimotor Risk DAG Narrative

- ❖ The Sensorimotor Risk is primarily derived from **Altered Gravity** environmental changes but also has effects from **Radiation, Hostile Closed Environment, and Distance from Earth**.
- ❖ Transitions to/from **Altered Gravity** environments have physical effects on the body:
 - **Fluid Shifts** – fluids shift between the lower body and the upper body.
 - **Musculoskeletal Loads** – physical loading/unloading of the musculoskeletal system.
 - **G-Receptor Loads** – changes in linear accelerations, including gravitational, acting on the G-receptor organs.
- ❖ These changes lead to physiological changes that affect:
 - **Vestibular Gain Recalibration** - the relationship between accelerations, including gravitational, and vestibular responses.
 - **Vision and Gaze Control** - vision is the ability to see and gaze control is the ability to orient the eyes, and maintain fixation, on a desired visual target. **Radiation** can induce cataracts that affect vision.
 - **Vestibular Motor Neuron Changes** - vestibular neurons adapt to reduced or increased firing rates and become more or less sensitive. **Radiation** and the **Hostile Closed Environment** are suspected to affect motor neurons.
 - **Proprioception** - a global term that encapsulates multiple internal sensors that monitor the position and movement of body segments relative to each other. This is often grouped with skin tactile sensation.
 - **Muscle Physiologic Changes** - reduced loading on muscle, tendons, and ligaments that cause both structural and functional **changes in strength**.
- ❖ All of these physiological changes alter the signals that must be interpreted by the brain and here is represented by **Multi-Sensory Integration Alterations**. **Radiation** and the **Hostile Closed Environment** effects on the central nervous system is suspected to affect this central processing.
- ❖ The central nervous system must integrate information from all of these systems. **Multi-Sensory Integration Alterations** can affect functional abilities and lead to impairments:
 - **Motion Sickness** occurs when vestibular and visual signals in the brain are conflicting.
 - **Fine Motor Control** limits the ability to perform tasks that require delicate control.
 - **Postural Control and Locomotion** refer to upright balance and the ability to walk that are required to perform physical tasks in a gravity environment.
- ❖ The severity of these functional impairments directly impacts **Individual Readiness** and **Crew Capability** and specific tasks including:
 - **Manual Control of Vehicles** which depends on **Fine Motor Control** and spatial orientation/perception.
 - **EVA (Risk)** through the increased likelihood of falls or injury.
 - **Crew Egress (Risk)** through the increased likelihood of falls or injury.
- ❖ These affect **Individual Readiness, Crew Capability** and through them **Task Performance** and other Mission Level Outcomes.
- ❖ **Distance from Earth** affects the mass, power, volume, and bandwidth allocations for **Vehicle Design** and the **Crew Health and Performance System** in particular. These include:
 - **Exercise Hardware** and **Exercise** which affects **Muscle Physiologic Changes** and **Postural Control and Locomotion**.
 - **Medical Treatment Capabilities** such as motion sickness medications.
 - **Medical Prevention Capabilities** such as the following countermeasures that are still experimental:
 - **Self-Administered Rehab**
 - **Sensory Augmentation**
 - **Balance Training**
 - **Pharm (Risk)** can include motion sickness medications such as Meclizine, Promethazine, Scopolamine, etc. that are susceptible to stability issues.
- ❖ **Artificial Gravity** as a countermeasure holds the potential to significantly reduce the Sensorimotor Risk but is high cost to implement.