Behavioral Health Analogs and Team Risk



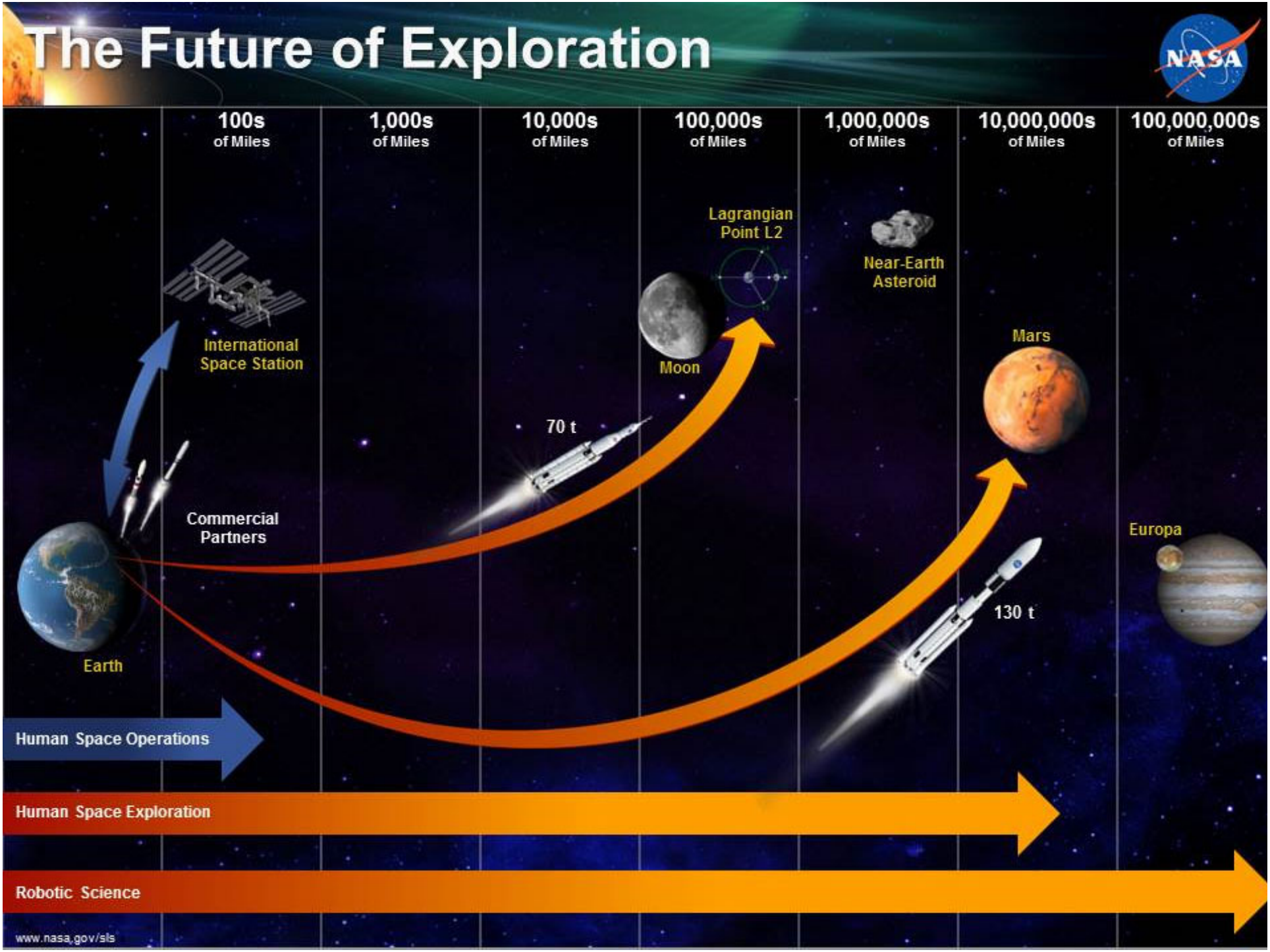
Peter G. Roma, Ph.D.
Lauren Blackwell Landon, Ph.D.
Sara E. Whiting, Ph.D.
Suzanne T. Bell, Ph.D.

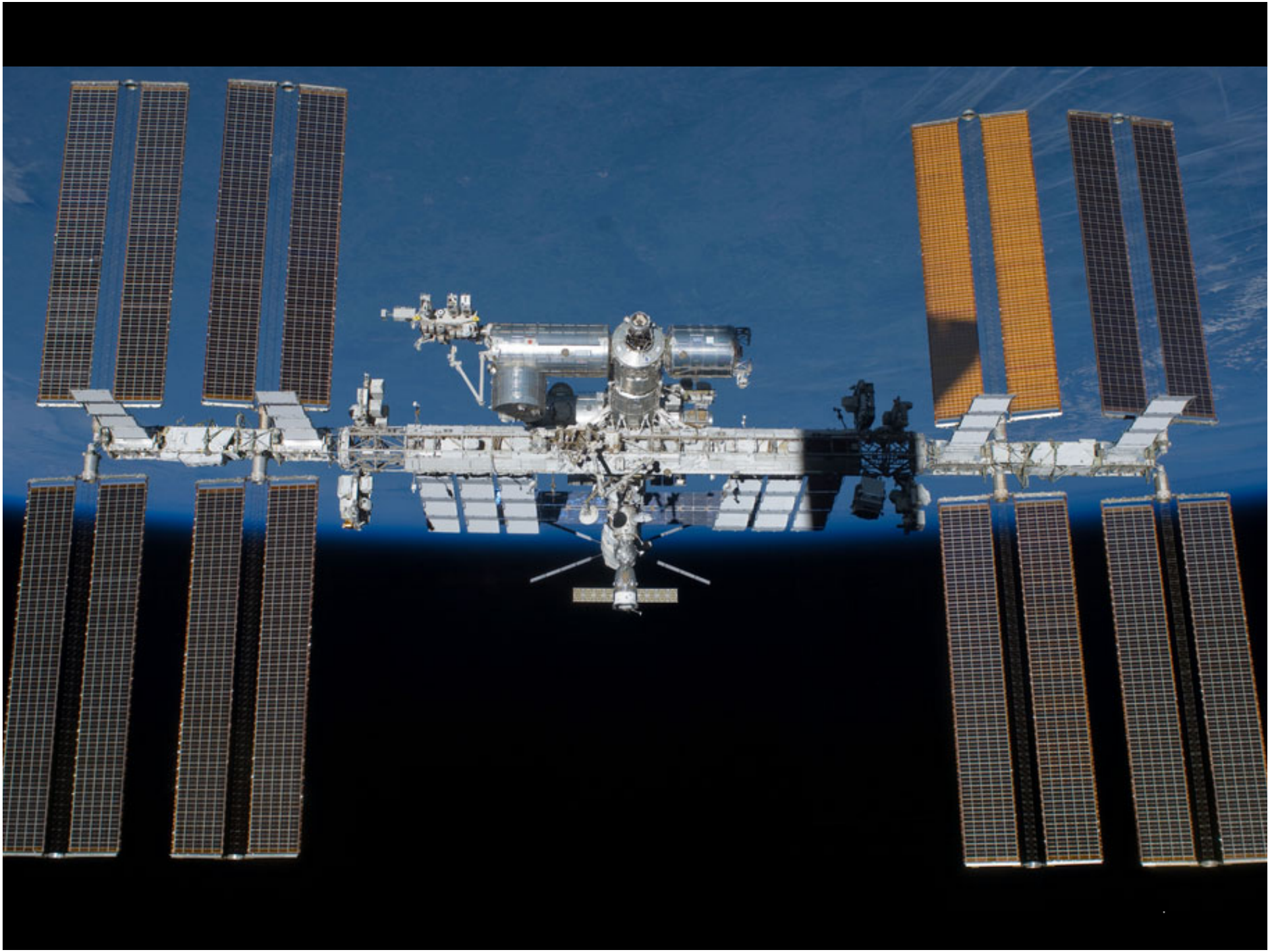
Behavioral Health & Performance Laboratory
Biomedical Research and Environmental Sciences Division
Human Health and Performance Directorate
KBR/NASA Johnson Space Center
Houston, TX, USA

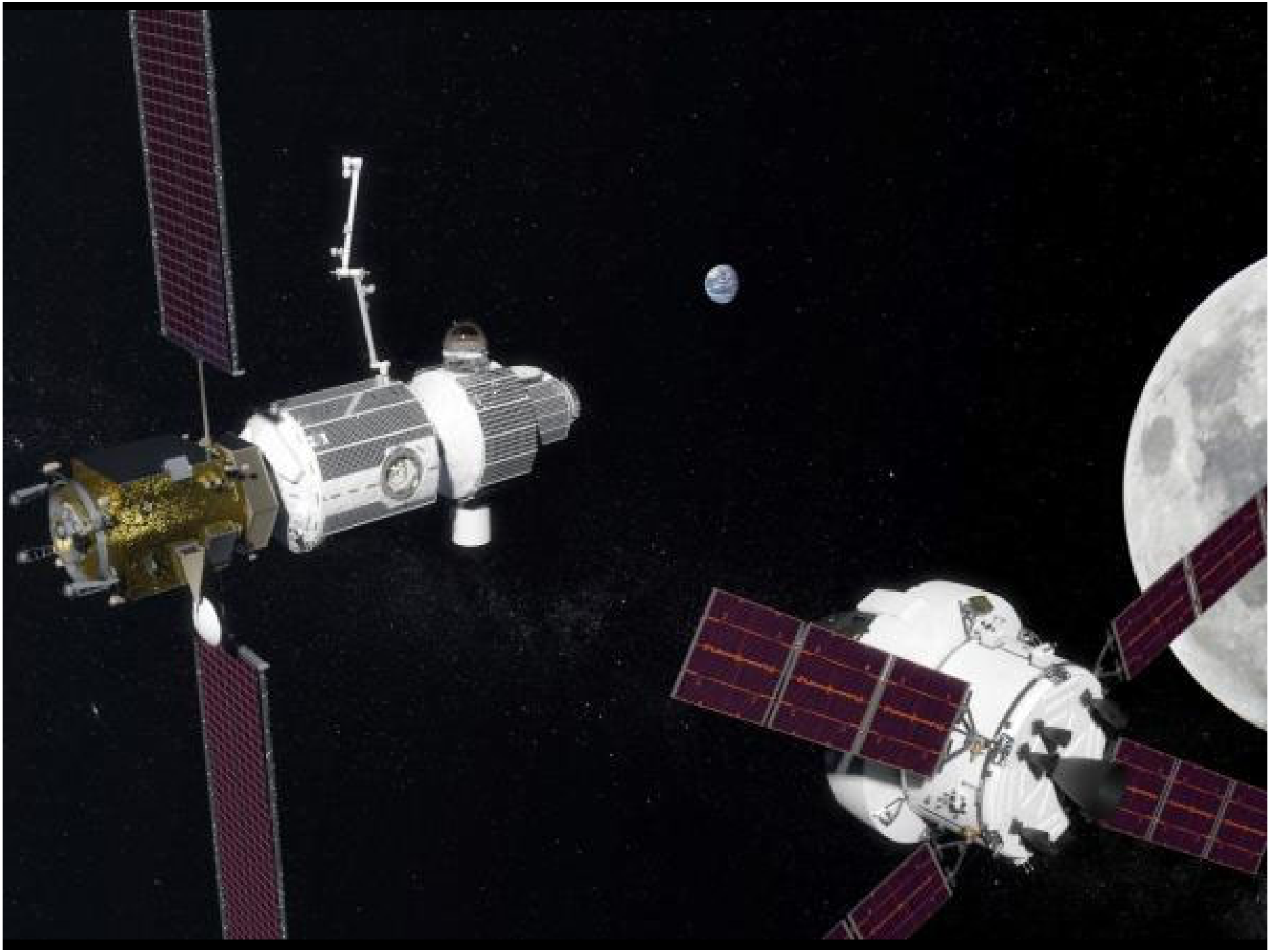
Disclosures

- No financial disclosures or conflicts
- Supported by the NASA Human Research Program
- Opinions expressed are those of the authors, not official positions of the US Government, NASA, TRISH, KBR, or affiliated Universities

The Future of Exploration








esa


6
Pat Rawlings '03

Spaceflight Hazards

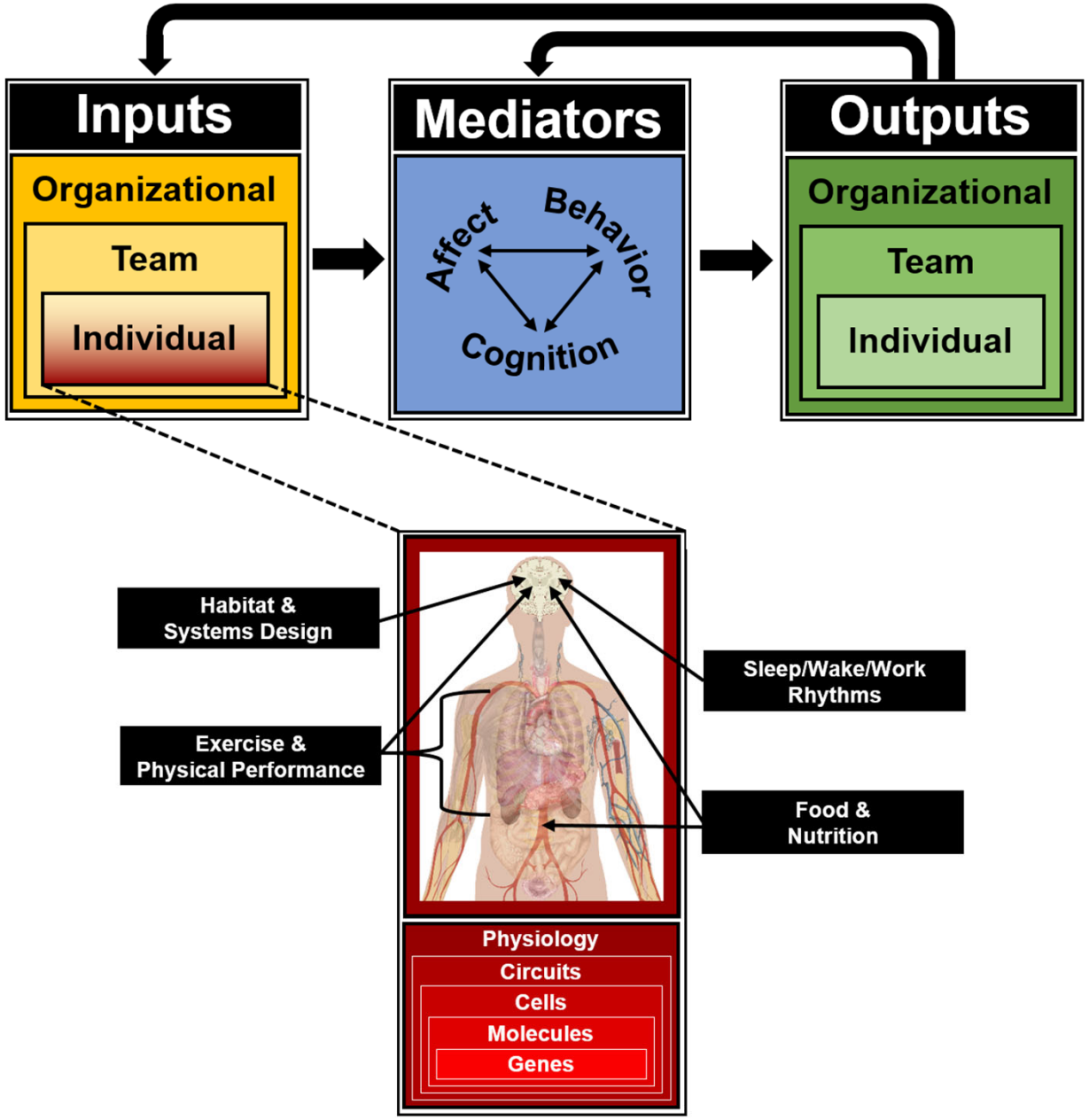
1. Radiation
2. Isolation/Confinement
3. Distance from Earth
4. Altered Gravity
5. Hostile/Closed Environment

Isolated, Confined, Extreme Environments (ICE)

- Isolated
  - Physical separation from civilization, community, social support
  - Communications constraints
- Confined
  - Physical habitat
    - Limited privacy, and inadequate space for work, social, and recreational activities, limited configurability and control (Kearney, 2016)
  - Social confinement
    - Crew limited to each other as the primary and often only source of social support, collegiality, and friendship
- Extreme
  - Dangerous external geophysical environment incompatible with human physiology, health, and well-being
    - Lack of or toxic atmosphere, temps, altitude, non-24 h light–dark cycles, wildlife threats (e.g., predatory animals, microorganisms, toxins), reduced gravity, and risk of exposure to radiation and other low-frequency/high-impact phenomena (e.g., solar flares, rough seas, dust storms, blizzards, high winds, and volcanism)

ICE Operational Environment Context

- Dynamic Closed System
  - Everything can affect everything
  - Beyond behavioral risks
  - Passage of time matters



Landon, L. B., Douglas, G. L., Downs, M. E., Greene, M. R., Whitmire, A. M., Zwart, S. R., & Roma, P. G. (2019). The behavioral biology of teams: Multidisciplinary contributions to social dynamics in isolated, confined, and extreme environments. *Frontiers in Psychology, 10*:2571. doi: 10.3389/fpsyg.2019.02571.

Individual and Team Behavioral Health Risks

- Behavioral Emergencies
- Diagnosable Disorders
- Behavioral Signs & Symptoms
- Cognitive Decrements

Behavioral Health Analogs

A Word on Analogs

- Analog, Model, Simulation
  - Analog ≈ model
    - Analogous
      - Share some fundamental defining feature(s) of the target system
      - “Ship in a bottle”
  - Underestimation vs Overestimation of Risk

- What is not included, what is simulated, and what is real

Analog Research

- Risk Characterization
  - Nature of individual and team behavioral health and performance adaptations to ICE conditions
  - Risk interactions
- Test Countermeasures
  - Opportunity for control, experimental design, sample size

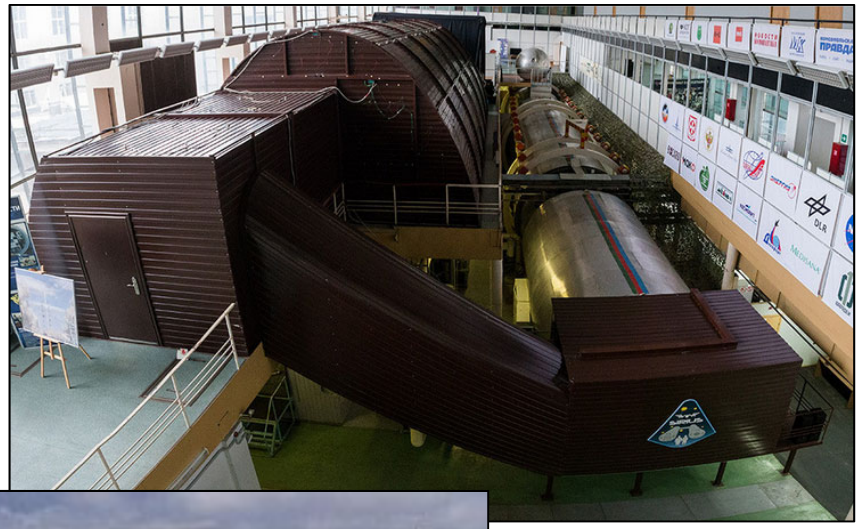
https://www.nasa.gov/analogs

Analog Research

- Antarctica: McMurdo Station, Concordia Station, Neumayer III Station

Analog Research

- Isolated, Confined, Controlled (ICC)
  - HERA, NEK/SIRIUS, HI-SEAS



Individual Behavioral Health

- Behavioral Emergencies

Prevalence	Risk	Source
1 attack with ice axe 2 arson (1 intoxicated, desire to be sent home) 1 attack with hammer 1 stabbing	Violence/ homicidality	Vostok Station (axe)- 1959 McMurdo (intox. arson)- 1981 Almirante Brown Station (arson)- 1984 McMurdo (hammer)-1996 Bellinghausen Station (stabbing)-2018
1/10 ‡	Depression (needing evacuation)‡	Polish Polar Station, Svalbard (Temp et al., 2020)
3/12 crew evacuated	'Severe Depression' GHQ elevations	A British station (Bell & Garthwaite, 1987)
1/36 crew	Suicidal ideation	Palmer Station (summer) (Pattarini et al., 2016)

‡No work performance deficit despite clear distress/mood despondency

Individual Behavioral Health

- Diagnosable Disorders

Prevalence	Risk	Population	Source
5.2% incidence	Any DSM-IV D/o (mood = 30.2% of d/o; adjustment = 27.9% of d/o, sleep-related = 20.9% of d/o; personality = 11.6% of d/o; substance use = 9.3% of d/o	Antarctic crew (with psych selection)	Palinkas et al., 2004
~5% incidence	Any ICD-9 D/o	Antarctic crew (no psych selection)	Norman, 1991

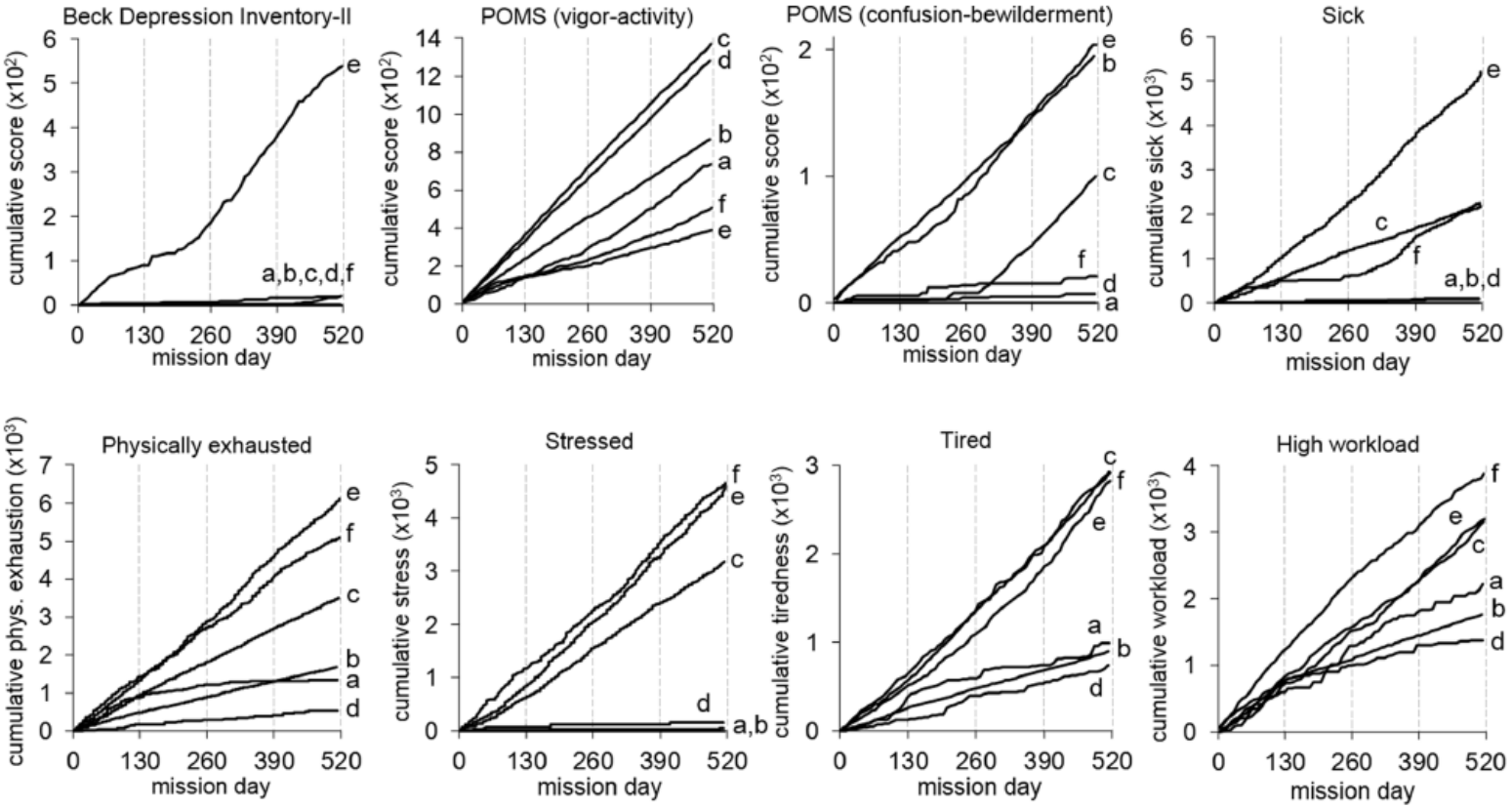
Individual Behavioral Health

- Behavioral Signs & Symptoms

Prevalence	Risk	Population	Source
2.66% of clinic consults	Mix of insomnia, anxiety, & depression	Indian Antarctic Station	Bhati et al., 2013
11.5% of winterover crew	Lethargy & loss of appetite	Indian Antarctic Station	Bhati & Pal, 2012
7% of 134 clinic visits	“Psych related” symptoms	Palmer Station Antarctica	Pattarini et al., 2016
62.1% self-reported depression symptoms	Depression symptoms/Winter-Over Syndrome	McMurdo Station, 1989 winter season	Palinkas, 1992
47.6% more irritable	Irritable/Winter-Over Syndrome	McMurdo Station, 1989 winter season	Palinkas, 1992
N=30	Net decreased engagement in coping activities over course of the mission. But small decrement.	Submariners, 23-day patrol	Van Wijk, 2018

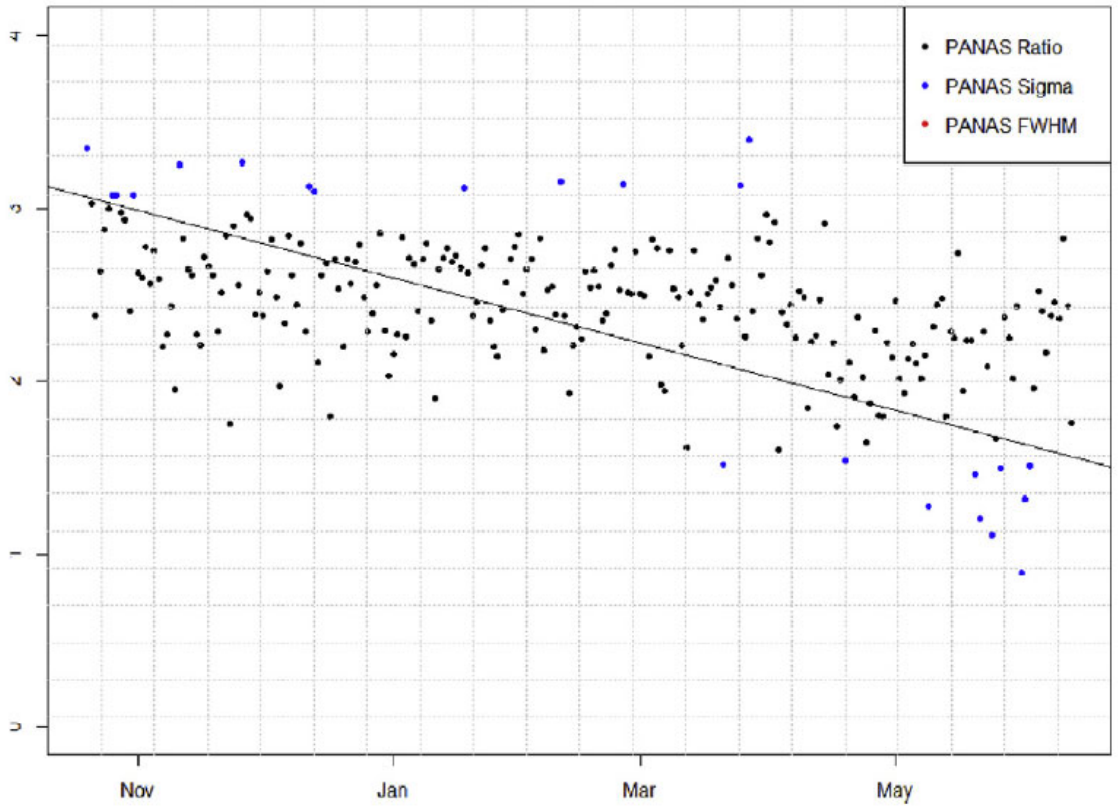
Individual Behavioral Health

- Individual differences in cumulative depressive symptoms and mood over 520-day mission (Basner et al., 2014)



Individual Behavioral Health

- Decrease in positive affect ratio over 8-month HI-SEAS mission (Engler et al., 2019)



Engler, S. T., Binsted, K., & Leung, H. (2019). HI-SEAS habitat energy requirements and forecasting. *Acta Astronautica*, *162*, 50-55.

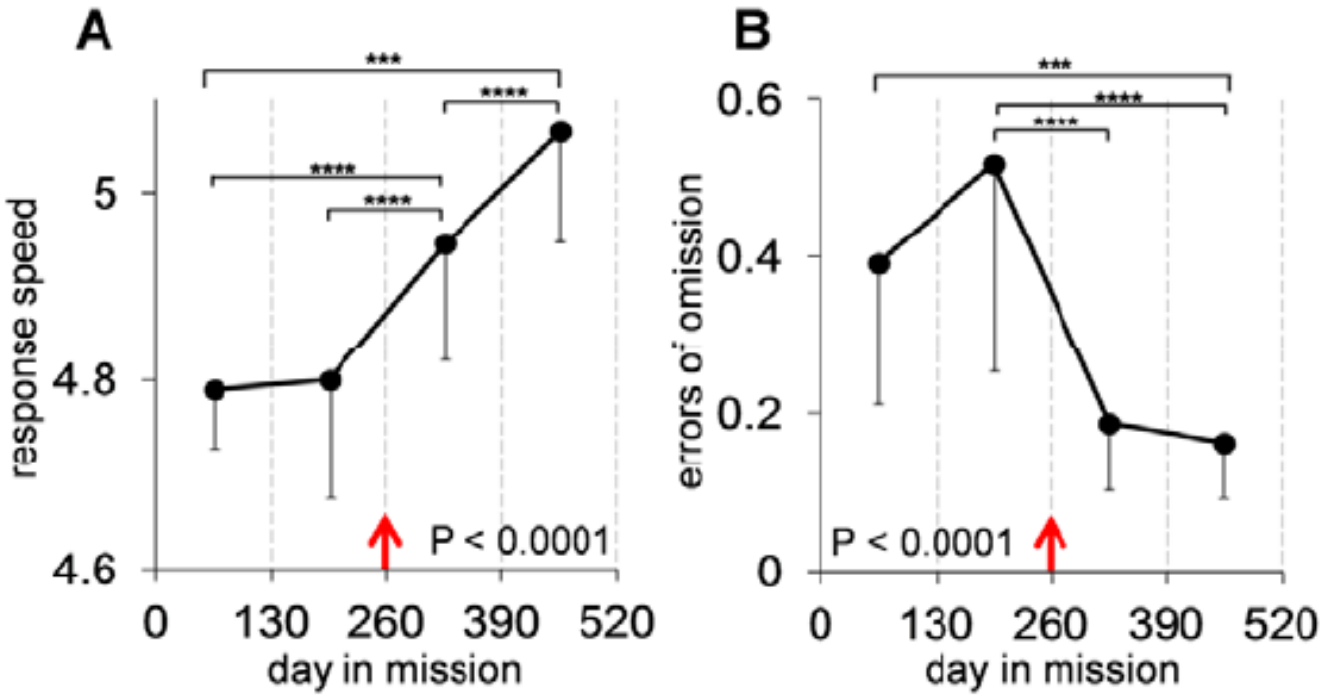
Individual Behavioral Health

- Cognitive Decrements

Prevalence	Risk	Population	Source
51.5 %	Reported difficulty with concentration or memory	McMurdo, 1989 winter season	(Palinkas, 1992)
N=1	Acute attention & memory deficit (context: hypoxic environment, inadequate nutrition, high physical workload, psychosocial stress)	Biosphere 2	(Lassinger et al., 2004)

Individual Behavioral Health

- Improved response speed and reduced lapses in vigilant attention after mid-mission Mars orbit and surface operations (Basner et al., 2013)



Team Behavioral Health

- Dozens of reported incidents of team process and conflict problems in long-duration spaceflight analogs, a few are listed below
- International Biomedical Expedition to the Antarctic
  - Reports of significant sub-grouping, conflicts, and intra-crew competition
  - One crewmember **evacuated** due to psychological issues, potentially related to interpersonal stressors
- SIRIUS Arctic patrols
  - Reports of significant interpersonal conflicts between patrol members, up to and including **cutting off interaction/communication** between patrol members
- 135d Mir simulation – Moscow
  - Evidence of crew breakdown over time, development of subgroups, intra-group tension
  - Self-reported cohesion significantly declined over time
- South Pole Station winter-overs
  - Crews with significant sub-grouping reported higher levels of depression, anxiety, anger, and fatigue than those that identified as a single cohesive group

Kanas, 2004; Natani, & Shurley, 1974; Palinkas, Gunderson, Johnson, & Holland, 2000; Sandal, 2004

Team Behavioral Health

NEK Long-Duration Chamber Studies

- Mars500 105d simulation – Moscow
  - Reported interpersonal differences increased over time
  - Reported interpersonal tension within the crew attributed to these differences increased over time
- Mars500 520d simulation – Moscow
  - Based on reports of social interaction, **one crewmember became socially isolated from the rest of the crew over the course of the mission**
  - Conflicts between crew and ground reported throughout mission, increasing up to and during 'surface' operations
  - Intra-crew conflicts reported throughout mission, increasing later in the mission
  - **Crew/ground conflict reported 5x more often than intra-crew conflict**

Basner et al., 2014; Sandal et al., 2011; Vinokhodova, et al., 2012

Summary

- Individual Behavioral Health
  - Emergencies rate, but high impact
  - Dx low prevalence, but
  - Sub-clinical alterations in neurobehavioral functioning
- Team Behavioral Health
  - No Dx per se
  - Social functioning major overlap with indiv behav health
  - Morale, cohesion, team/social dynamics, conflict management
- Largely positive, achievement, growth opportunity

Challenges for Behavioral Health Analogs

- Protocol Integration
  - Quality of evidence relates to quality of crew experience
  - Multidisciplinary, multi-level
- Meaningful Work
  - Increasing fidelity of model
  - Moon as analog for Mars
- There is no analog for time!
  - Long-duration missions
  - Time is critical variable for individual and team behavioral health risk

Look Ahead for Behavioral Health Analogs

- HERA
  - Upcoming campaigns focus on human-computer interaction and integration
- NEK/SIRIUS
  - 4-month mission completed, preparing for 8-month, possible 12-month
- Ongoing Continuing work in Antarctic stations

ICE Context

- Dynamic Closed System
  - Everything can affect everything
  - Passage of time matters
  - Beyond behavioral risks

- **Multiple interacting pathways to increase risk = multiple interacting pathways to reduce risk!**

Ongoing Work on Behavioral Health Countermeasures

- Identification and recommendations for essential selection and composition factors for long-duration missions
- Development and validation of pre-mission and in-mission training to support individual and team behavioral health
- Development and validation of tools for monitoring and predicting individual and team behavioral health
- Development and validation of in-mission countermeasures to maintain and repair individual and team behavioral health
  - Cross-cutting

https://humanresearchroadmap.nasa.gov/Tasks/

Onward and Upward!

Pete.Roma@nasa.gov