Behavioral Health & Performance (BHP)
Work-Rest Cycles

October 17, 2011

Lauren B. Leveton, PhD
NASA Space Medicine Division/SD4
Element Manager

Alexandra Whitmire
NASA / Wyle Integrated Sciences and Engineering
Sleep Risk Area Manager

Outline

- Overview
- Evidence
- Mitigations

Overview: BHP Goal & Requirements

BHP Program Element Goal

Identify, characterize, and prevent or reduce behavioral health and performance risks associated with space travel, exploration and return to terrestrial life

BHP Requirements

- Characterize and assess risks (e.g., likelihood and consequences)
- Develop tools and technologies to prevent, monitor, and treat adverse outcomes
- Inform standards
- Develop technologies to:
  - reduce risks and human systems resource requirements (e.g., crew time, mass, volume, power)
  - ensure effective human-system integration across exploration mission systems

Overview: BHP Human System Health and Performance Risks

BMed Risk

- Risk of Adverse Behavioral Conditions
- Risk of Psychiatric Disorders

Team Risk

- Risk of Performance Decrements due to Inadequate Cooperation, Coordination, Communication and Psychosocial Adaptation within a Team

Sleep Risk

- Risk of Performance Errors due to Fatigue resulting from Sleep Loss, Circadian Desynchronization, Extended Wakefulness and Work Overload

Evidence: Work-Rest Cycles in Space

Evidence indicates that work-rest cycles are *stressors* in current spaceflight

- Stuster (2010) found that "work" was the most frequently discussed category in ISS journals (number of entries=976). Both high workload (n=73) and "low workload" (n=48) were discussed, along with "schedule" (n=163), "tedious/frustrating" (n=133), and "work is good" (n=133).
  - *The lack of "padding" in the schedule means that there is little time to accomplish small tasks, or to recover from mistakes*
  - *I'm ready for the weekend. The past couple of days of reduced sleep and eating opportunities have added a little strain. I felt it especially yesterday. Today, the fatigue and hunger are present but not the strain.*

- In interviews with 76 Shuttle Flyers, when asked to identify factors that hindered sleep, 11% of the responses indicated that workload, timeline, and schedule issues hindered sleep; additionally, 21% of responses revealed that "thinking" about upcoming tasks, concerns or anxiousness about the mission also hindered sleep (Whitmire, Slack, Locke, Keeton, Patterson, Faulk and Leveton, 2011).

Evidence: Work-Rest Cycles in Space

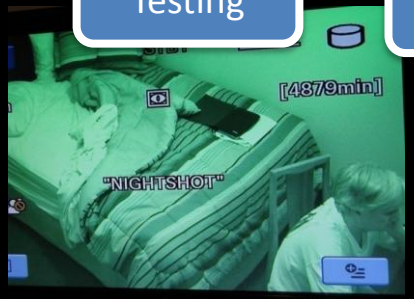
- Preliminary data analysis from Barger and Czeisler (2010) indicate that in spite of regular medication use, average nightly sleep duration on the ISS remains just around over six hours.

- Causes of reduced sleep may include:
  - Workloads and shifting schedules
  - Lack of earth day-night cues
    - There are 16 sunrises and sunsets outside of the ISS each day
    - Internal lighting on ISS is reportedly dim. Sixty percent of ISS Habitable Volume is below 300 lux, and according to the Illumination Society of Engineers (industry standard org.), most serious human cognitive work requiring illumination begins at 300 lux. Crews daily must find and use additional lighting sources for many tasks (e.g. maintenance).

Mitigations

Sleep Medication Testing

Pre Bedtime Testing → Alarm Awakening Testing → Morning Testing



Lighting Research Recommendations for ISS

Stress Management Training

Sleep Education and Countermeasures For Ground Controllers

Exploration LDM Presents New Challenges

Going Beyond LEO

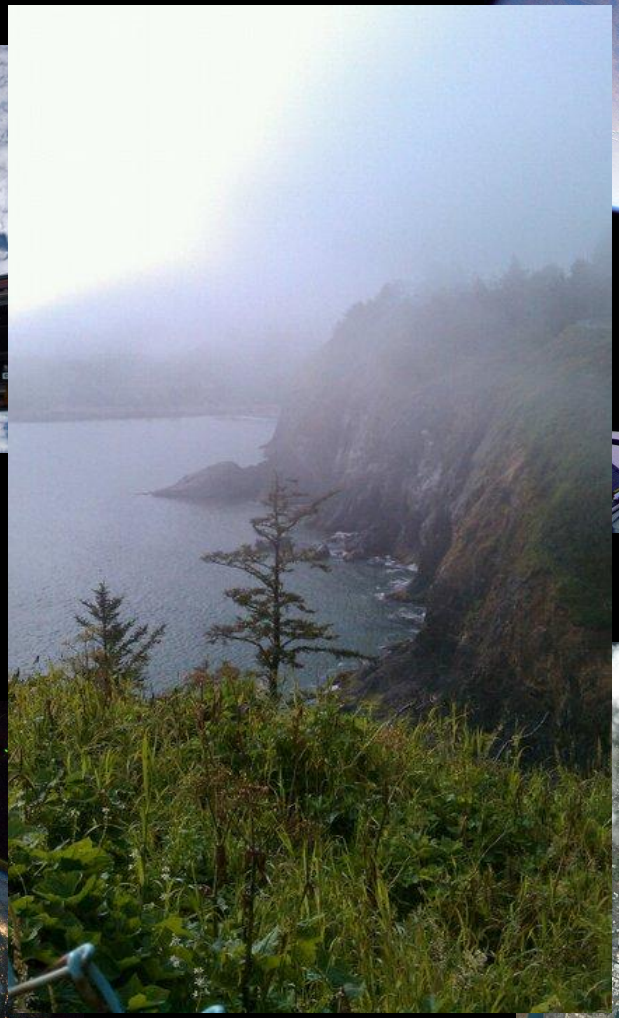
- Future exploration missions will require extremely long duration stays in remote, isolated, dangerous and confined environments
- Physiological and behavioral impacts from day and night cycles that differ from standard Earth time
- Sensory and social stimulation will be limited
- Teams composed of only a few individuals will experience prolonged confinement in a small controlled habitat
- Operations will become increasingly autonomous and will include: conditions of delayed communication, extended periods of heavy workload, and long periods of monotony

Mitigation - Team

- Evidence indicates that *team cohesion* can serve as a buffer against deleterious outcomes
  - Several crewmembers indicated that to mitigate fatigue effects on performance, the team remained vigilant of one another's fatigue levels and covered one another accordingly (Whitmire et al., 2011)

- Unobtrusive measures of team performance for exploration missions are being developed and validated

- Research on team training to inform current training protocols for flight and ground crews
- Countermeasures for communication and autonomous operations
  - Virtual Therapist for conflict management
  - Study of team performance under conditions of com delay for ISS



Mitigation – Behavioral Medicine

- Given the extended duration of future missions and the isolated, extreme and confined environments, there is a possibility that (a) adverse behavioral conditions will occur; and (b) mental disorders could develop should adverse behavioral conditions be undetected and unmitigated.

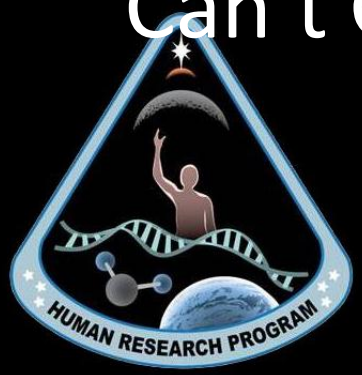
- Preventative Countermeasures, such as Stress Management Virtual Therapist, Sensory Stimulation through Immersive Technologies, and methods through which to mitigate social monotony, are being developed specifically for the long duration Exploration environment.

- Future habitats and mission operations concepts are being developed with input from BHP.

Deliverables

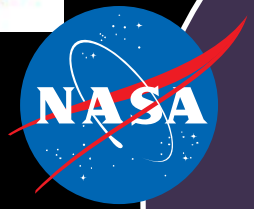
- Risk Characterization and Knowledge
- Preventative Countermeasures
- Monitoring Technologies
- Treatment Countermeasures

Can't Go It Alone – BHP Collaborators



BHP

Research Community



Exploration Strategies

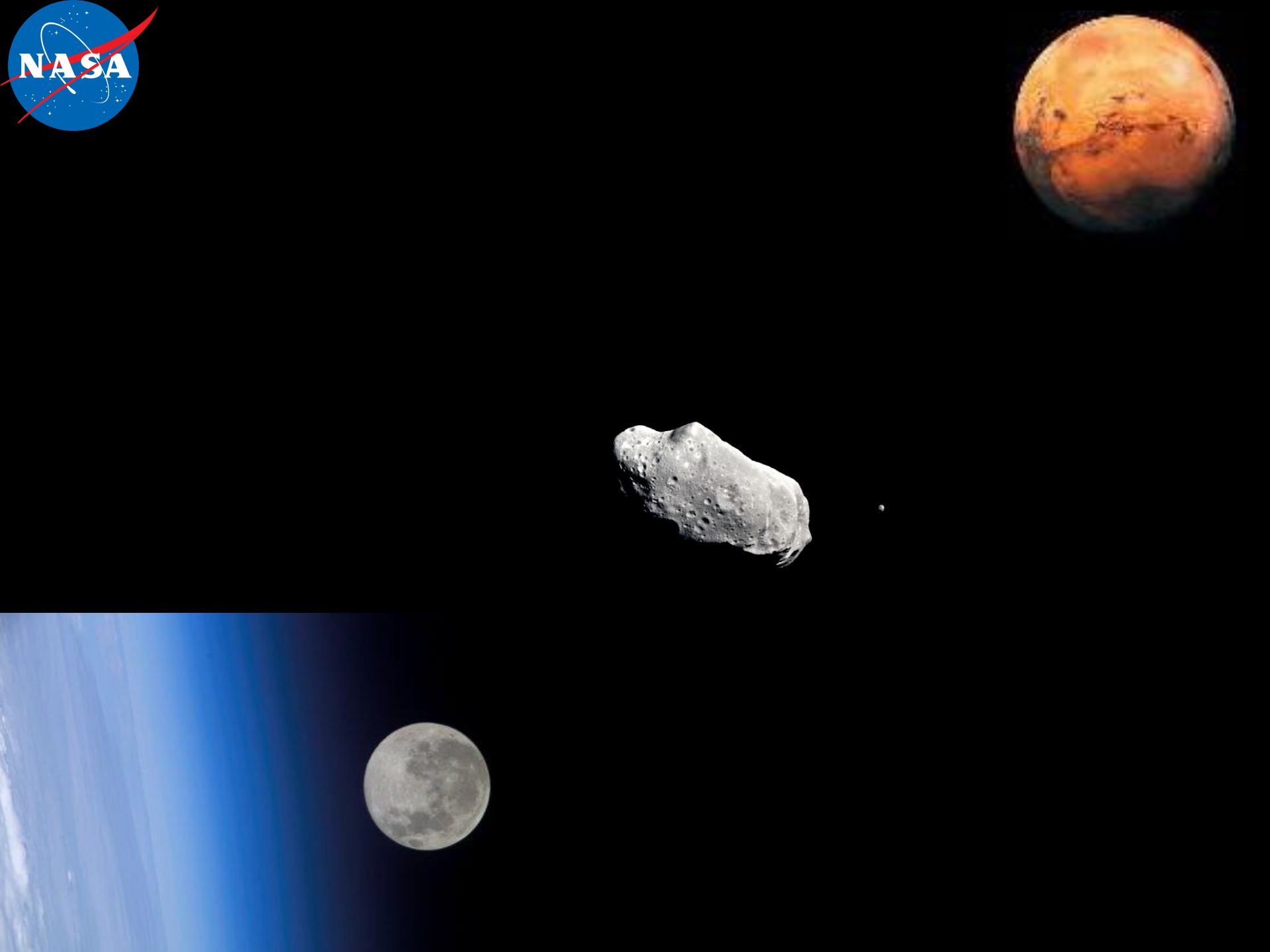
NASA Operations & Operators

-SD

- MOD

- CB

International Partners


NASA