NASA
Human Research Program
Behavioral Health and Performance
Program Element





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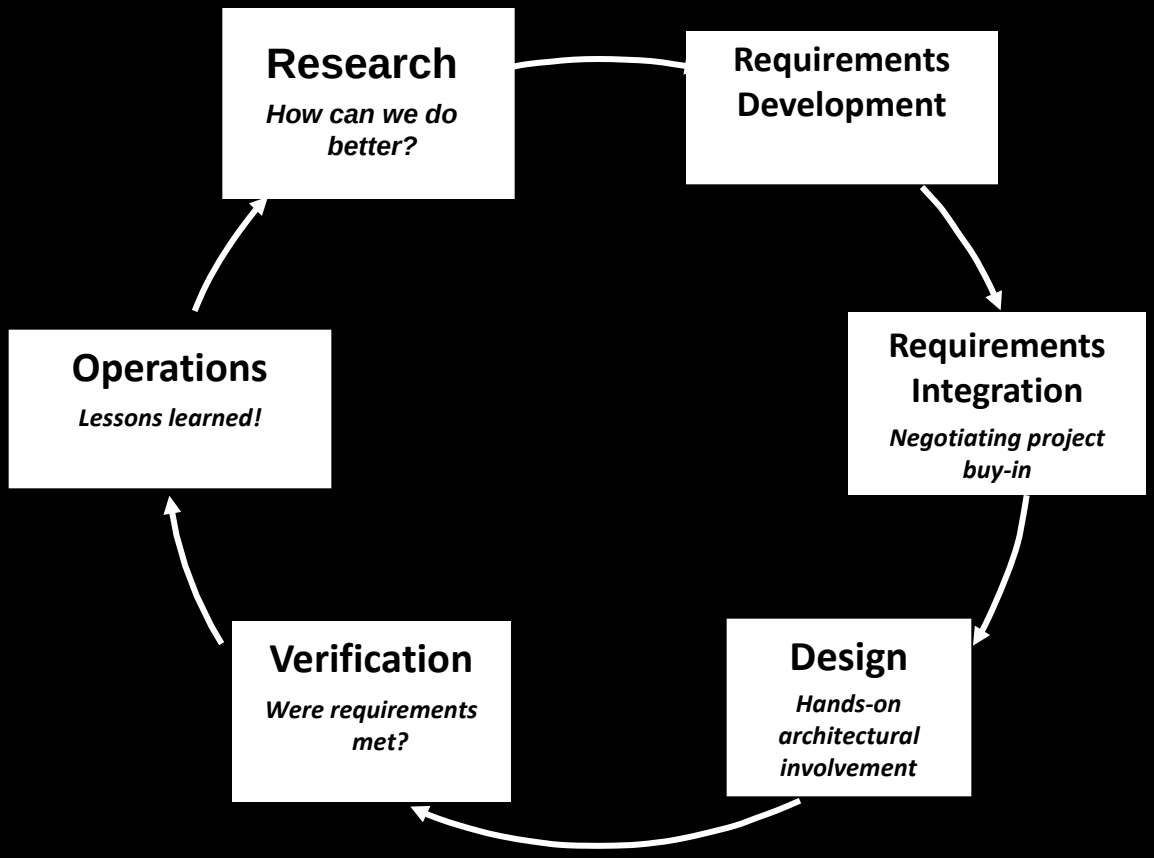
Element Manager

Human/System Integration Process



Risk of Performance Errors due to Sleep Loss, Fatigue, Circadian Desynchronization, and Work Overload

Risk of Performance Errors Due to Poor Team Cohesion and Performance, Inadequate Selection/Team Composition, Inadequate Training, and Poor Psychosocial Adaptation

Risk of Behavioral and Psychiatric Conditions

Performance effects

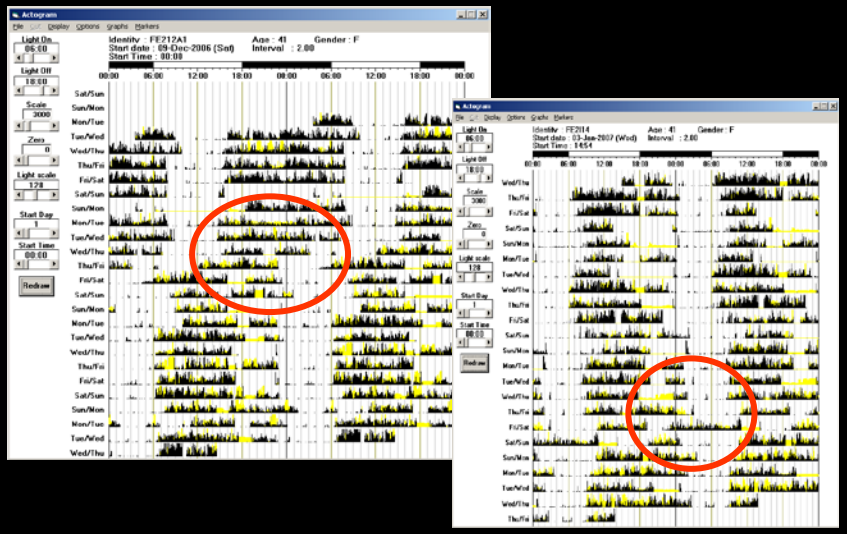
Long term health effects

Short term health effects

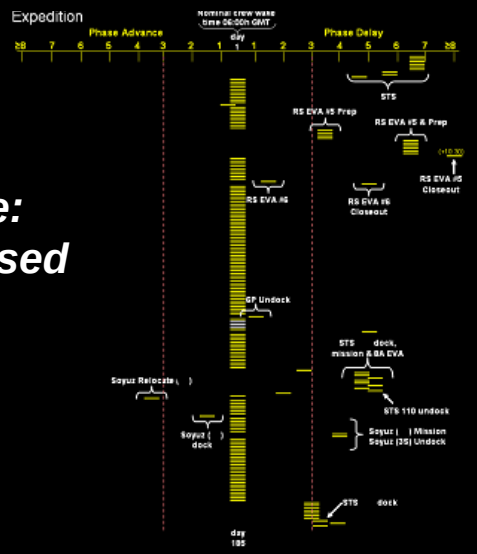
As Ops views Research…

Donning his new canine decoder, Professor Schwartzman becomes the first human being on Earth to hear what barking dogs are actually saying.

… and, as Research views Ops



Evidence:
Space - Based



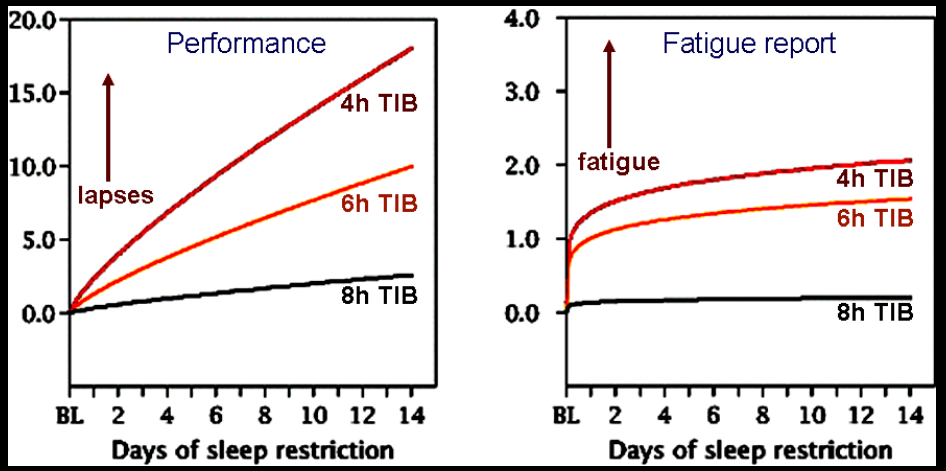
Source	Average Hours of Sleep	Missions	Subjects (N)	Measurement Tool
Dijk *et al*., 2002	6.5	STS-90, STS-95	5	PSG, Actigraphy
Kelly *et al*., 2005	6.0	STS-89	4	Sleep Logs
Monk *et al*., 1998	6.1	STS-78	4	Sleep Physiology
Gundel *et al*., 1997	6.1	Mir	4	Sleep Physiology
Santy *et al*., 1988	6.0	STS Missions	58	Post-flight debrief
Frost *et al*., 1976	5.8	Skylab	3	Physiology

Evidence – Ground-based: Performance Decrements

Ground studies have shown that minor sleep deprivation (no sleep in the past 18 hours) lead to impaired cognitive and motor performance, comparable to impairments seen in those with .05% - .1% blood alcohol levels (Williamson and Feyer, 2000; Dawson and Reid, 1997; Arnedt et al., 2001)

Individuals may not be aware of their performance deficits from inadequate recovery sleep. Laboratory and field studies have found this to be the case (Dinges et al. 1999; Van Dongen et al., 2003; Belenky et al. 2003; Dinges et al., 2005; as cited in Leveton and Dinges, 2006)

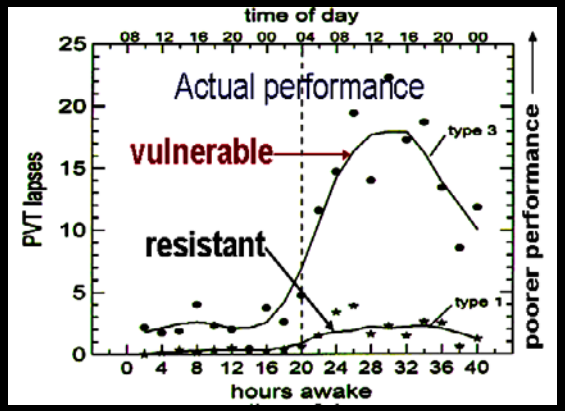
Being very impaired after chronic sleep restriction was perceived as only mild fatigue

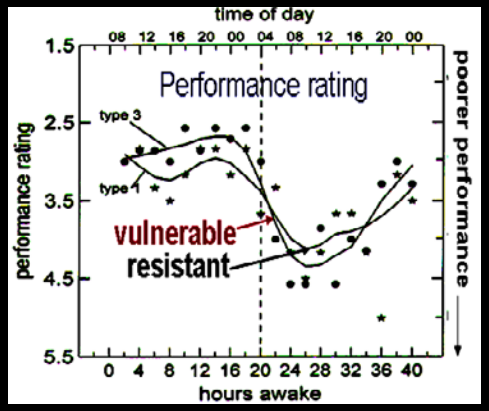


Evidence: Performance Decrements

Some astronauts need less sleep and/or may be more resistant to the effects of sleep loss on brain functions. Laboratory and field studies have found this to be the case for 10%-30% of people when sleep loss is mild to moderate (Van Dongen et al., 2004, 2005; LeProult et al., 2003; Caldwell et al., 2005)—evidence level 1.

People can differ greatly in performance deficits from sleep loss, but not perceive it.



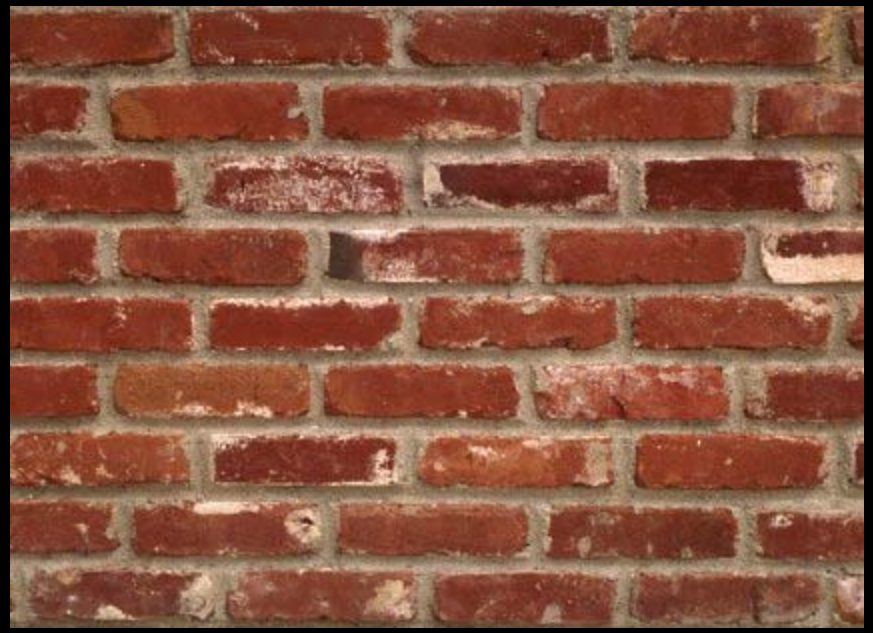


Preliminary findings from Actiwatch Protocol / Sleep – Wake Flight Study indicate that individual vulnerabilities and different mission characteristics (e.g., noise, temperature) contribute to variability in data (Barger and Czeisler, preliminary unpublished data, 2008)

Evidence: Long-Term Health Outcomes

A wide range of serious long-term health consequences are associated with chronic, or cumulative, sleep loss:

- hypertension
- diabetes
- obesity
- heart attack
- stroke
- psychiatric disorders such as depression or severe anxiety.



Cultural Issues:

"To understand sleep – wake activity, let's study Gyroscopes on the Station"

Research *Deliverables*
Transition to Medical Operations
for *Medical Requirements*

The Transition Process:

- applies best practices for space exploration
- evaluates the effectiveness and operational *readiness* of human system health and performance-related research deliverables
- supports the Agency's human spaceflight programs

Transition to Operations Steps

1. Description of the deliverable or product (detailed description, intended use, how it addresses a human system risk)
2. Data required to demonstrate efficacy, effectiveness, or utility of deliverable
3. Data required to demonstrate operational validation of the deliverable
4. Implementation plan describing specific use or application (e.g., protocol, regimen)
5. Analysis of mission resources required for implementation (e.g., crew time, power, mass, volume, etc.)

CRL 1-3: Hypothesis formulation, validation; CRL 4-5: Concept formulation, proof of feasibility;
CRL 6: Lab testing, efficacy; CRL 7: Integrated testing of cm in analog/simulated environment;
CRL 8: Validation in spaceflight to demonstrate efficacy and operational feasibility;
CRL 9: CM fully flight tested, ready for operational implementation

SLEEP RISK

HRP Evidence Reports

Actigraphy Protocol:
-Sleep Diary
-Actiwatch
-Terrestrial and on-orbit sleep-wake activity

Informs Gaps

Transition to Ops

Research Gaps:

-Does sleep loss continue on long duration missions, or is there adaptation?
-How is performance affected?
-How can individual vulnerabilities to sleep loss best be determined?
-What are the best tools to monitor and assess decrements due to fatigue, sleep loss, and other spaceflight factors?

Informs Countermeasure Development

Gap: What are the best tools to monitor and assess decrements due to fatigue, sleep loss, and other spaceflight factors?

Psychomotor Vigilance Test

-extensively validated with pilots, physicians, shift workers

NEEMO Missions:

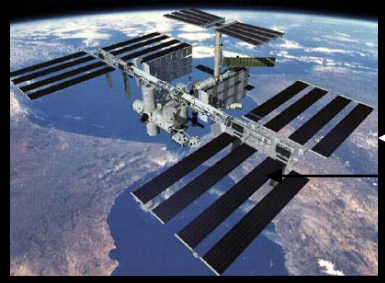
- **Feasibility with astronauts**
- **Norms on astronauts**
- **Sensitivity to fatigue, etc.**

Obtained normative data from NEEMO crewmembers

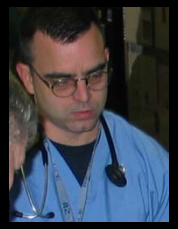
Developed 3-minute PVT Self Test interface feedback combined with performance algorithm

Evaluate PVT SelfTest interface with astronauts who helped develop tests norms and with comparable individuals in analog environments

ISS Study



Transition to Ops



HRP Evidence Reports

Flight Rules MRID

Gap: How can light be used in flight as a countermeasure?

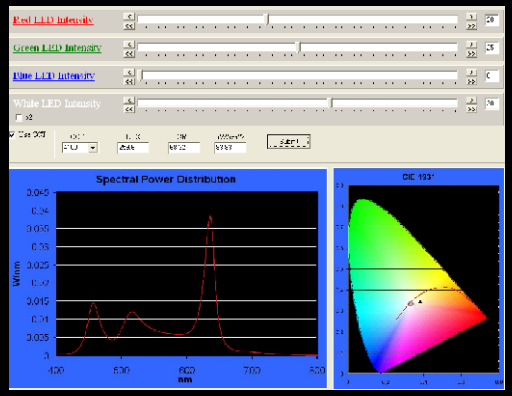
Evidence shows that light serves as an effective countermeasure for circadian entrainment, alertness

Characteristics of Light

Constellation

Operational regimen for Using light as countermeasure

Ops



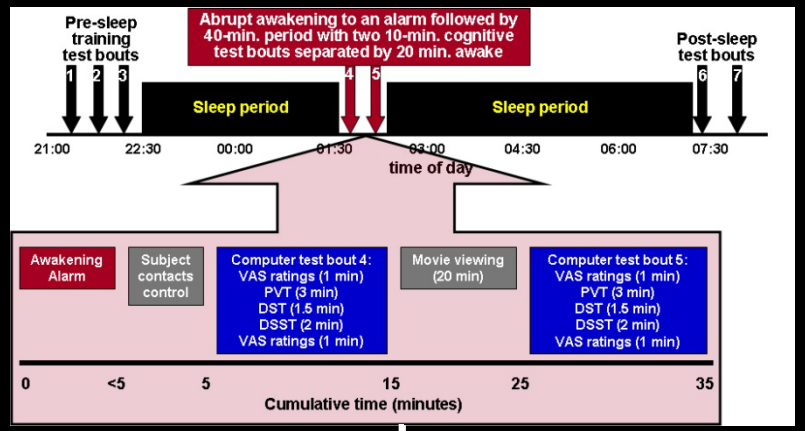
Acute, mid and long term effects

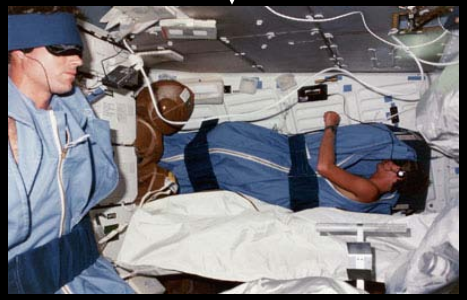
Gap: What are the best individual dosing requirements/protocols for Sleep and alertness medications during spaceflight?

(1) Determine best individual dosages

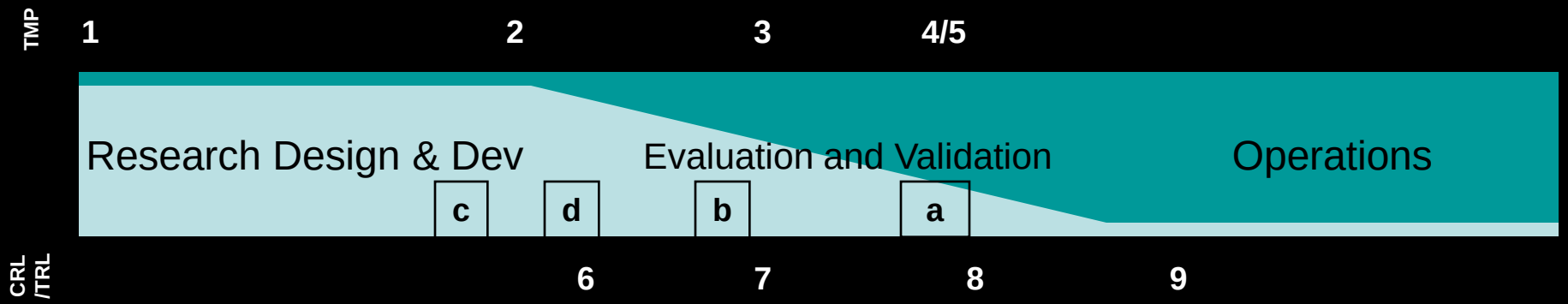
(2) Assess carry-over effects upon abrupt premature termination of sleep (to simulate an emergency situation)

(3) Transition the data and protocol as best practices for medical operations





BHP Research Deliverables
Transition to Medical Practices



a) Actigraphy Protocol
b) PVT Self Test
c) Blue Light Solid State Light Module (SSLM)
d) Individualized Sleep Medication Protocol