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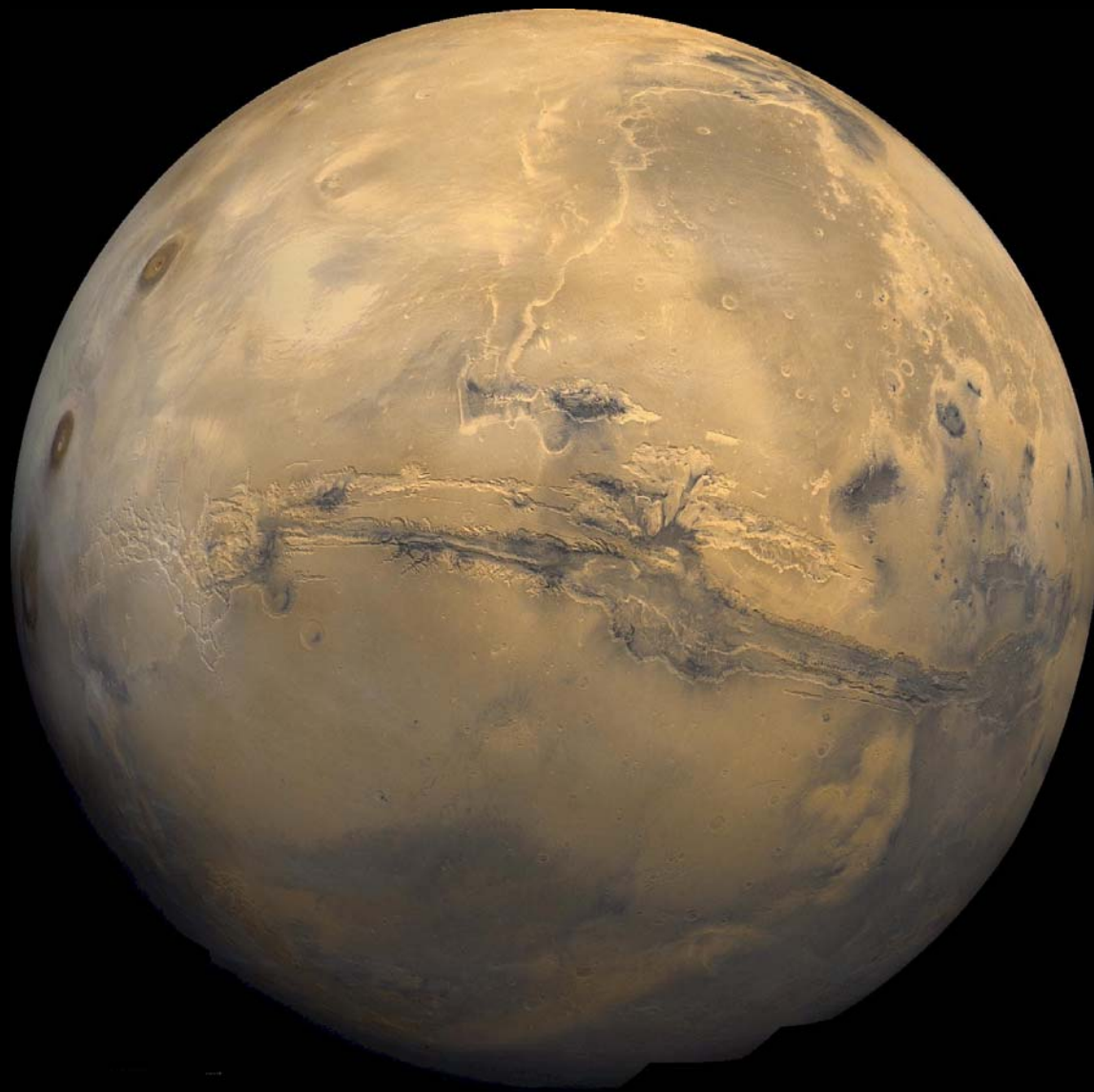
Behavioral Systems Management of Confined Microsocieties: An Agenda for Research and Applications

Henry H. Emurian & Kip Canfield
UMBC

Peter G. Roma, Eric D. Gasior, & Zabecca S. Brinson
Institutes for Behavior Resources

Robert D. Hienz, Steven R. Hursh, & Joseph V. Brady
Johns Hopkins University School of Medicine





[washingtonpost.com](http://www.washingtonpost.com) > [Columns](#)

Time to Boldly Go Once More

By Buzz Aldrin

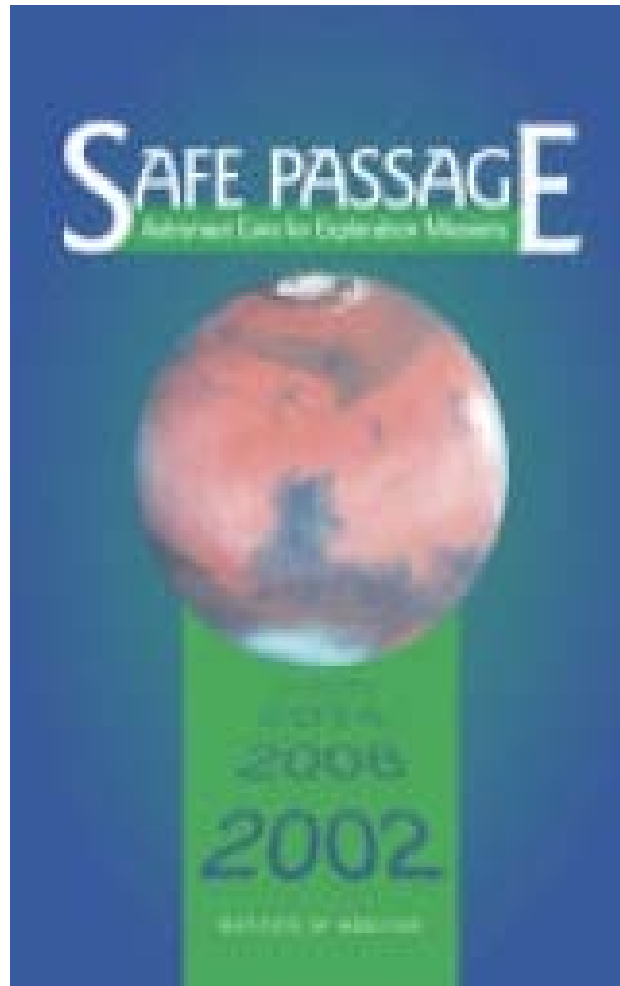
Thursday, July 16, 2009

*Much has been said recently about the Vision for Space Exploration and the future of the international space station. As we all reflect upon our historic lunar journey and the future of the space program, I challenge America's leaders to think boldly and look beyond the moon. Yes, my vision of "Mars for America" requires bold thinking. But as my friend and Gemini crewmate Jim Lovell has noted, our Apollo days were a time when we did bold things in space to achieve leadership. **It is time we were bold again in space.***

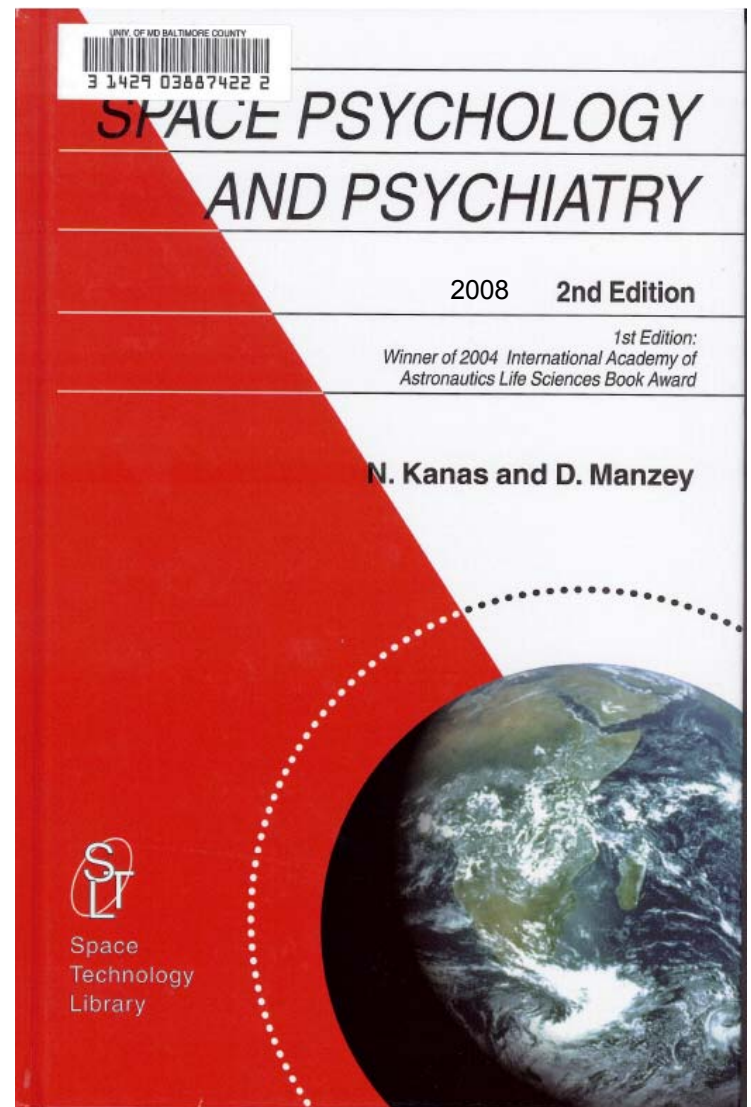
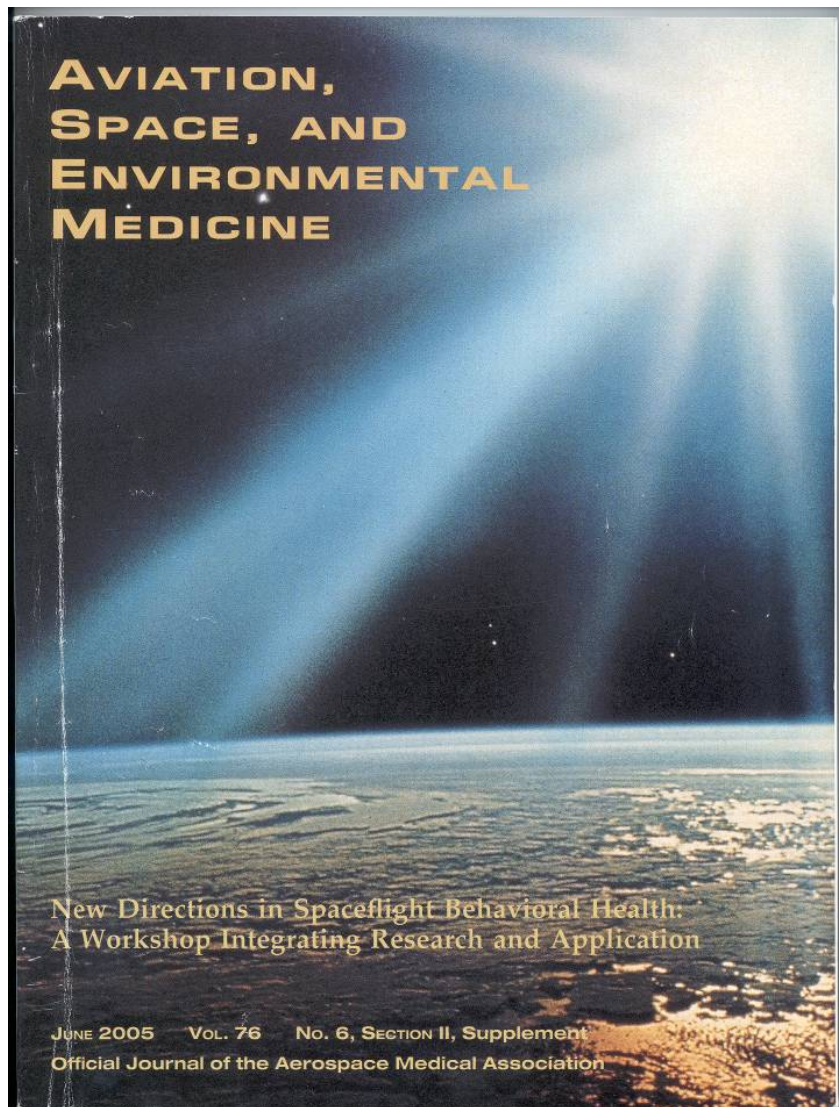


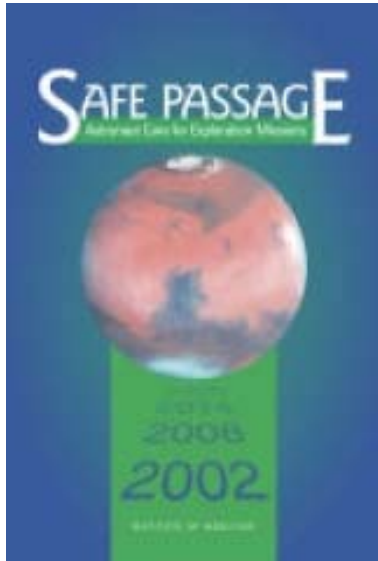
- **Extended stays** by human groups in extraterrestrial vehicles and habitats will be common in this century.
- Ensuring participants' **behavioral health** requires consideration of innovative approaches to microsociety management.



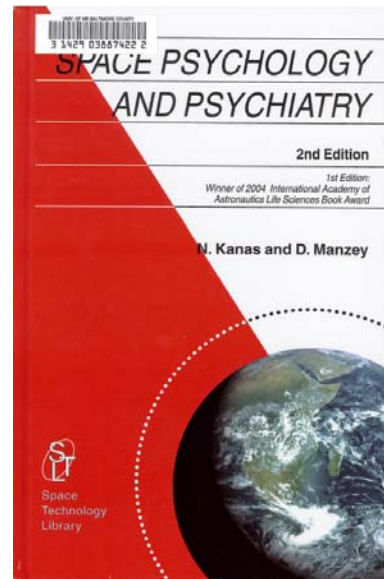
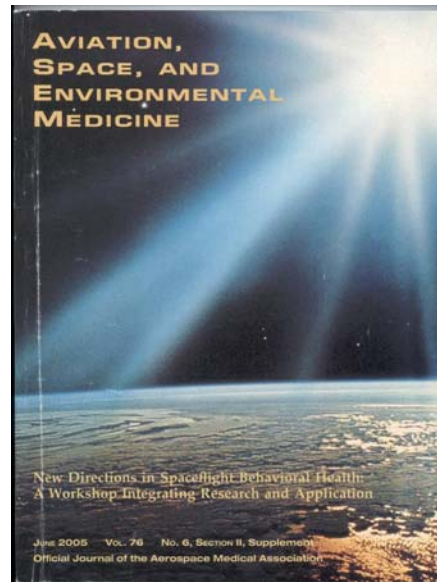


http://books.nap.edu/html/safe_passage/reportbrief.pdf





+



Conclusion?

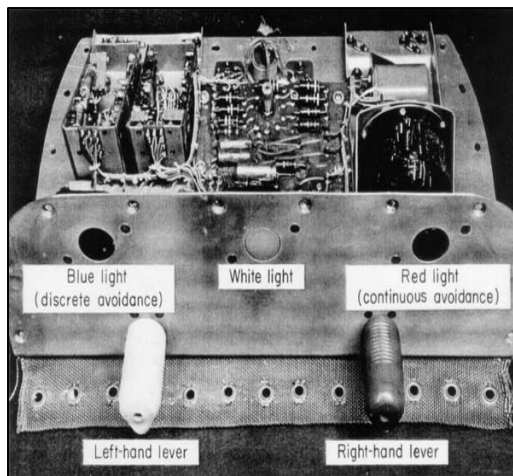


Life in Space Will Not Be Easy





Fig. 4. Chimpanzee training device for animal pretest flights of Project Mercury. Personal collection of the author.



http://lsda.jsc.nasa.gov/scripts/photoGallery/detail_result.cfm?image_id=1804

Time	Crew	Ops
06:00-06:10	CDR,FE-1,FE-2, FE-3	Morning inspection
06:00-06:05	FE-5	SLEEP - data logging FE5
06:00-06:05	FE-4	SLEEP - data logging FE4
06:05-06:35	FE-4,FE-5	Post-sleep
06:10-06:40	CDR,FE-1,FE-2	Post-sleep
06:10-06:20	FE-3	MO-8. Test config
06:20-06:35	FE-3	Body mass measurement
06:35-06:50	FE-4	Body mass measurement
06:35-06:50	FE-5	Breakfast
06:35-07:05	FE-3	Post-sleep
06:40-07:30	CDR,FE-1,FE-2	Breakfast
06:50-07:30	FE-4	Breakfast
06:50-07:05	FE-5	Body mass measurement
07:05-07:15	FE-3	MO-8. Concluding steps
07:05-07:30	FE-5	Breakfast
07:15-08:05	FE-3	Breakfast
07:30-07:50	FE-4	Nutrition and Repository – urine sample collection
07:50-07:55	FE-2	Ham radio HW prep
07:50-08:00	FE-4	Nutrition и Repository – installing first urine samples into MELFI
07:55-08:00	FE-5	Nutrition и Repository. Photographing
07:55-08:05	FE-2	Ham radio session
08:00-08:20	FE-4	Nutrition и Repository – blood sample collection
08:00-08:15	FE-5	Nutrition и Repository – blood sampling operator
08:00-08:05	FE-1	Nutrition и Repository. Photographing
08:05-08:15	FE-3	Verifying absence of cooling agent on housing of half-coupling 4ГБ4 КОБ2
08:15-09:15	FE-3	FE ВЕЛО - 4
08:20-08:30	CDR,FE-1	Remove Oxygen Unit БК-3 and БРТА battery / ODF
08:20-08:30	FE-4	Nutrition и Repository – assembling cooling centrifuge equipment
08:20-08:40	FE-5	Nutrition – urine sample collection

“Behavioral Program”

15:30-16:30	CDR	Orlan water tank refill
15:30-15:35	FE-5	Nutrition – installing urine sample into MELFI
16:00-17:15	FE-2	FE ARED
16:30-16:45	FE-1	Post EVA PMC (S-band)
16:30-17:00	CDR	EVA photos downlink
16:45-17:00	FE-1	Food questionnaire
17:00-18:00	CDR	FE ARED
17:00-18:00	FE-1	FE CEVIS
17:20-18:20	FE-3	FE ЭСПАНДЕР – 1
17:40-19:30	FE-2	3 min long video of science experiment
17:40-17:55	FE-4	PFC (S+Ku-band)
18:00-19:30	FE-1	FE ARED
18:20-18:50	FE-3	Hygiene
18:40-19:00	FE-5	Nutrition – urine sample collection
18:50-19:30	FE-3	COЖ maintenance БМП fan grille cleaning
18:50-19:10	FE-4	Nutrition and Repository – urine sample collection
19:00-19:05	FE-5	Nutrition – installing urine sample into MELFI
19:10-19:15	FE-4	Nutrition и Repository - installing urine sample into MELFI
19:15-19:20	FE-4	TVIS CEVIS HRM data transfer to MEC
19:20-19:25	FE-4	OCA SSC router reboot
19:25-19:30	FE-4	OCA SSC server reboot
19:30-21:30	.	Pre-sleep (supper, daily food ration, pre-sleep)
21:30-06:00	.	Sleep

Notes:

- 1 Window 9 cover opening – crew discretion, Report to MCC
2. Missing links to US ops – see OSTP

http://www.nasa.gov/mission_pages/station/timelines/06_2009_tl.html



MAIN CONTROL PANEL

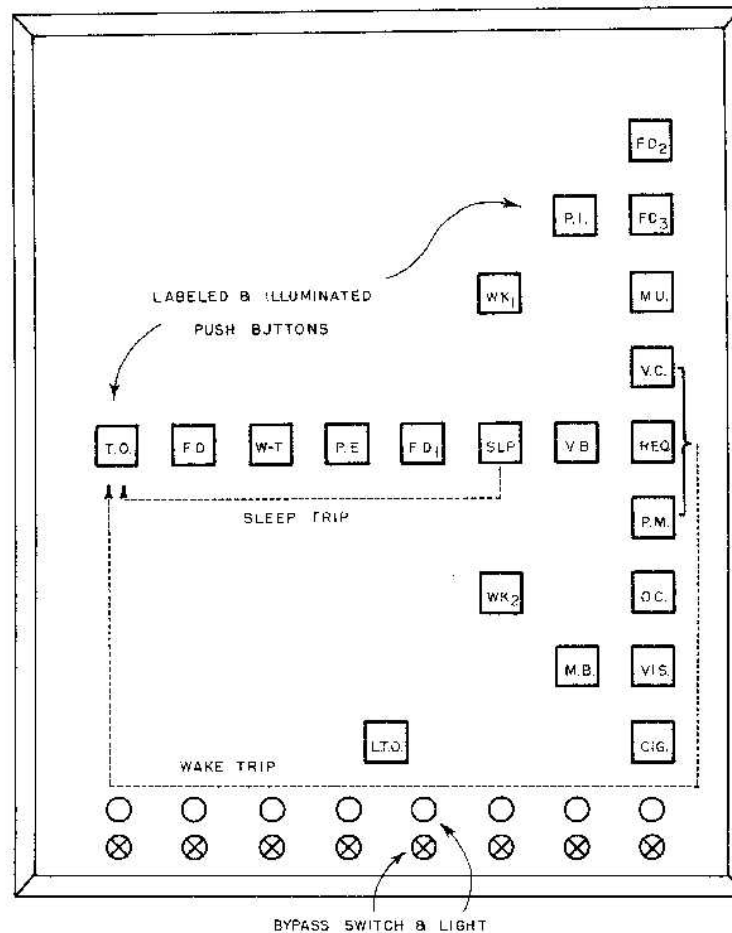


Figure 1. Main control panel containing push buttons that could be illuminated red or green. Each button is labeled with the abbreviations of the activity represented. "Wake Trips" and "Sleep Trips" are indicated by arrows.

Behavioral program supporting a single resident of a programmed environment for **152 days**. The multi-operant features are determined by activity alternatives at the transition points.



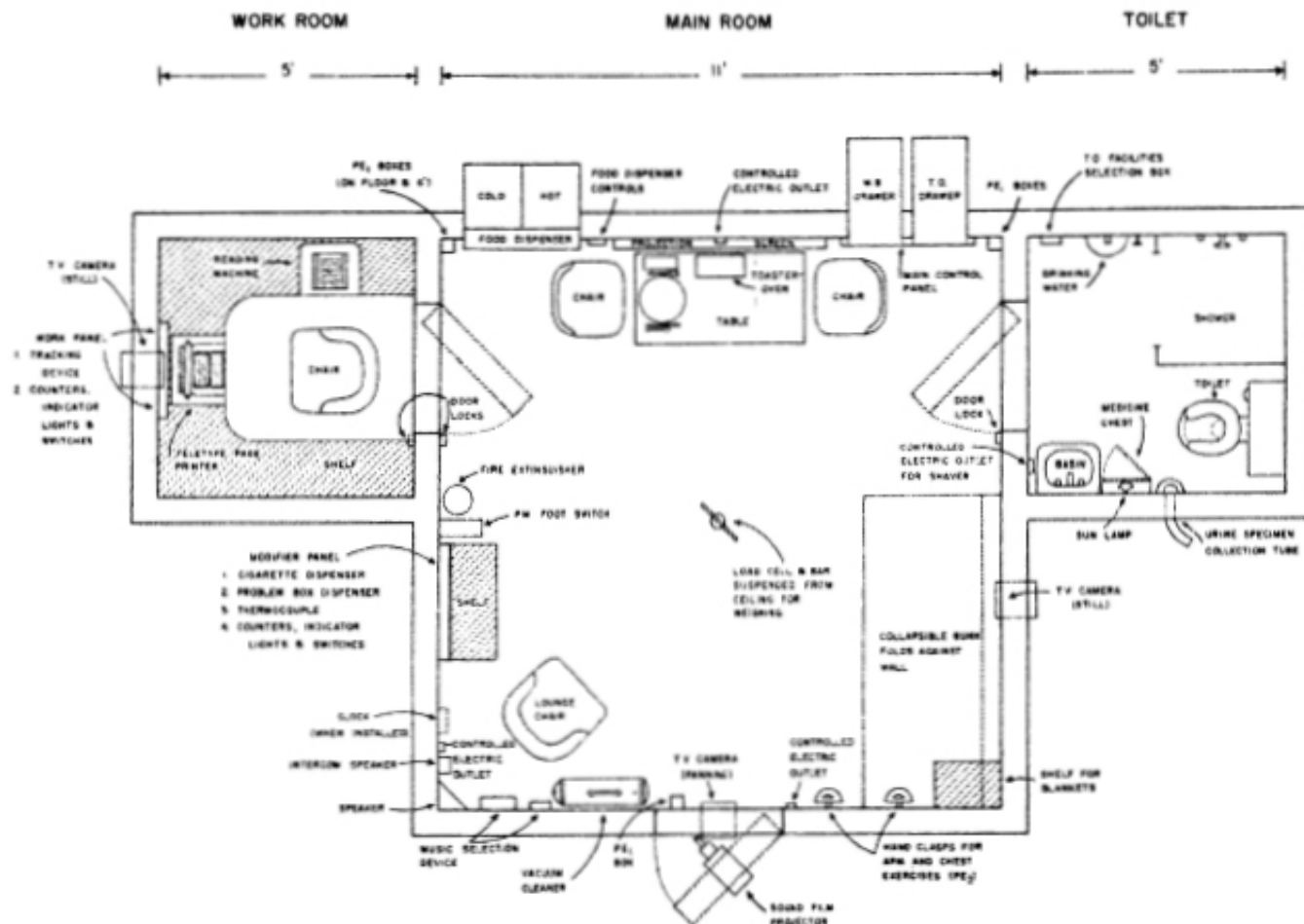


Fig 1. Diagram of experimental chamber showing furnishings and facilities in each room.

Findley, J.D., Migler, B.M., & Brady, J.V. (1963). A long-term study of human performance in a continuously programmed experimental environment. Technical Report NASA. p. 12.
http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19640001916_1964001916.pdf

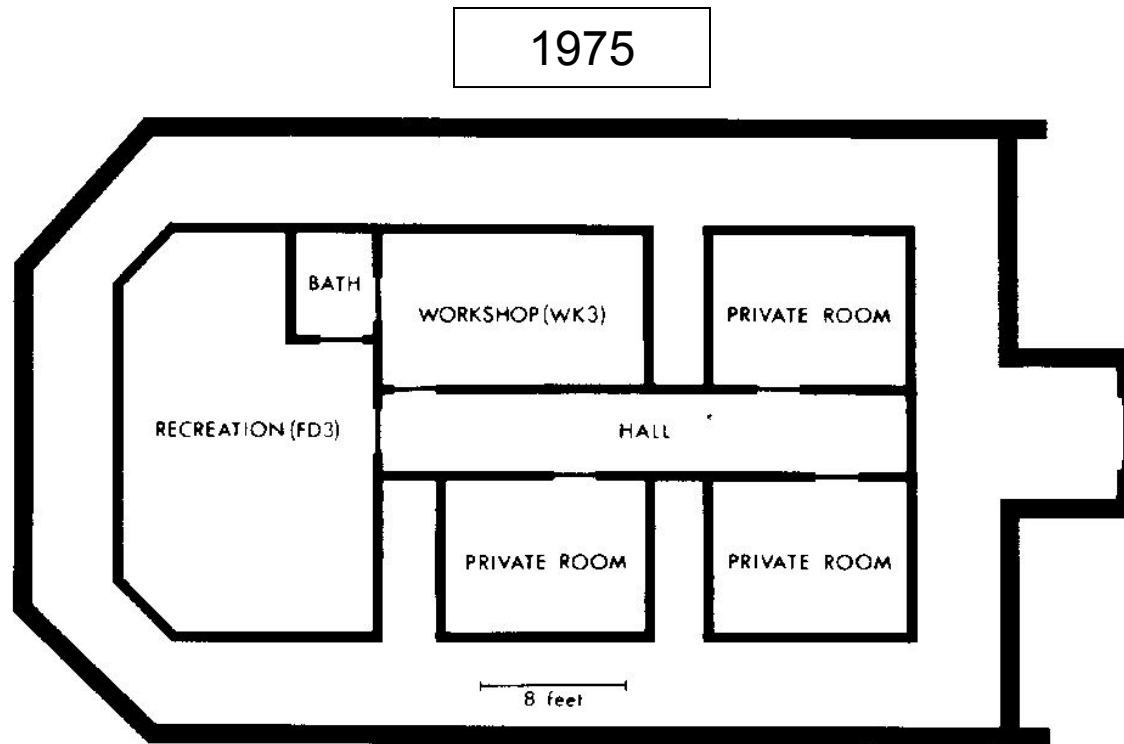
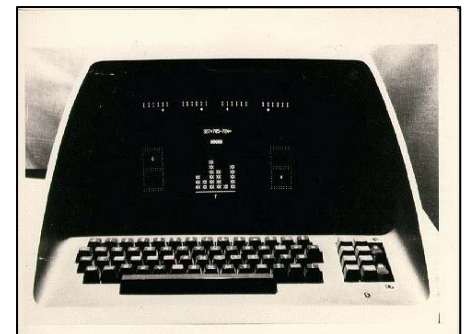
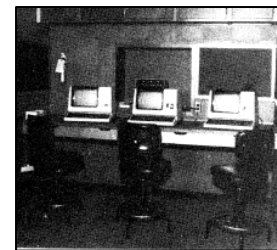
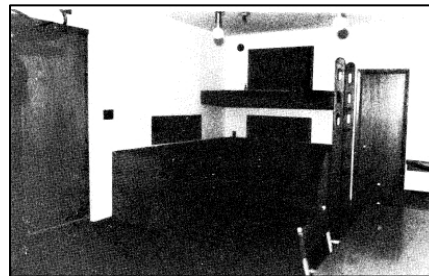
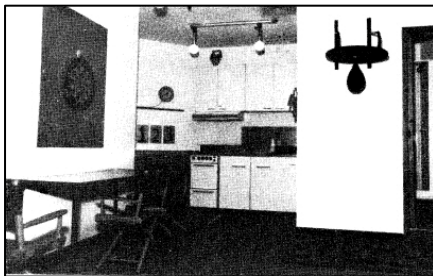
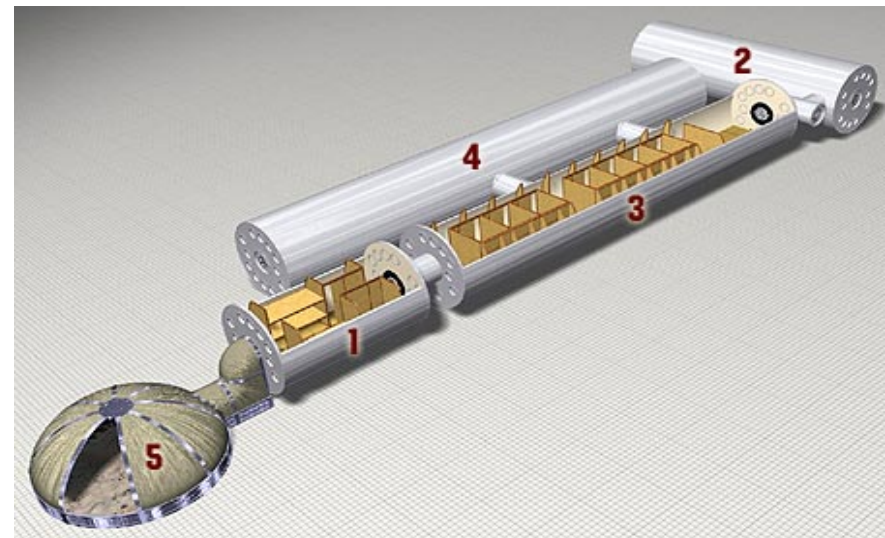


Fig. 1. A schematic diagram of the programmed environment.





- To Members of the NSBRI Board of Directors, External Advisory Council, Board of Scientific Counselors, User Panel, Industry Forum and Investigator Community:
- **105-Day Mars Simulation: U.S. studies focus on improving work performance**
- *Release available at:*
<http://www.nsbri.org/NewsPublicOut/Release.epl?r=123>
- HOUSTON – (July 13, 2009) – From **March 31 to July 14**, a six-man international crew called an isolation chamber in Moscow their home. The crew, composed of four Russians and two Europeans, simulated a 105-day Mars mission full of experiments and realistic mission scenarios, including emergency situations and 20-minute communications delays.



MAIN CONTROL PANEL

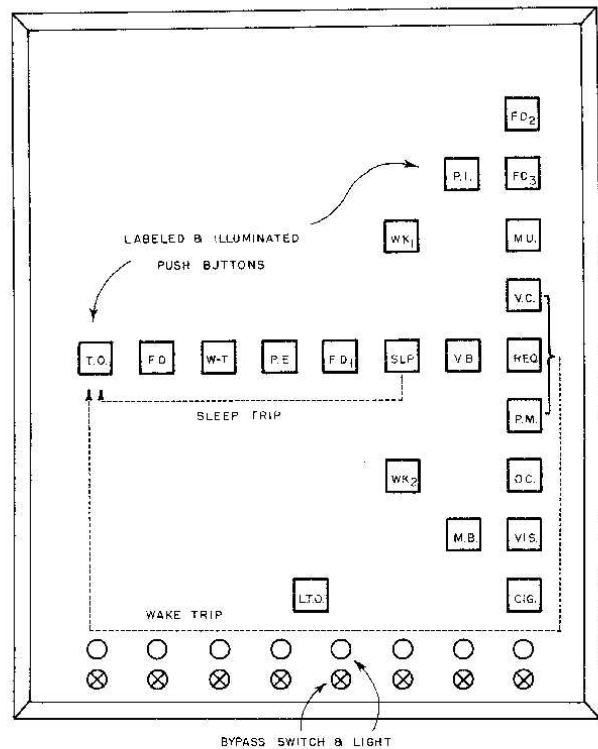
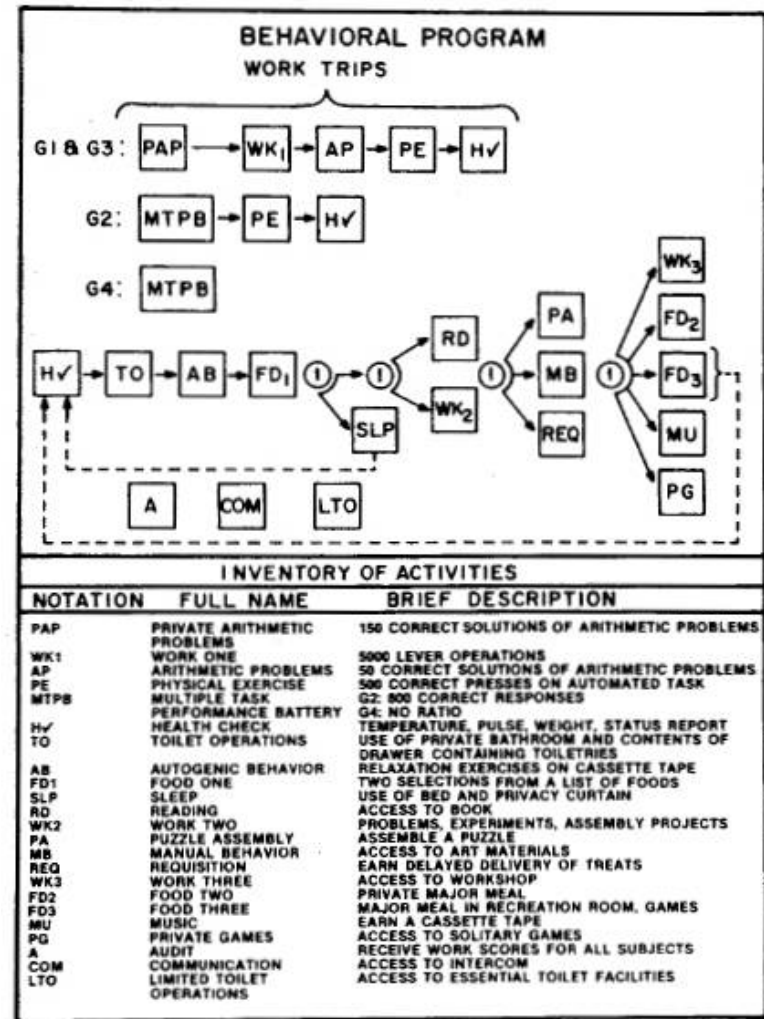


Figure 1. Main control panel containing push buttons that could be illuminated red or green. Each button is labeled with the abbreviations of the activity represented. "Wake Trips" and "Sleep Trips" are indicated by arrows.

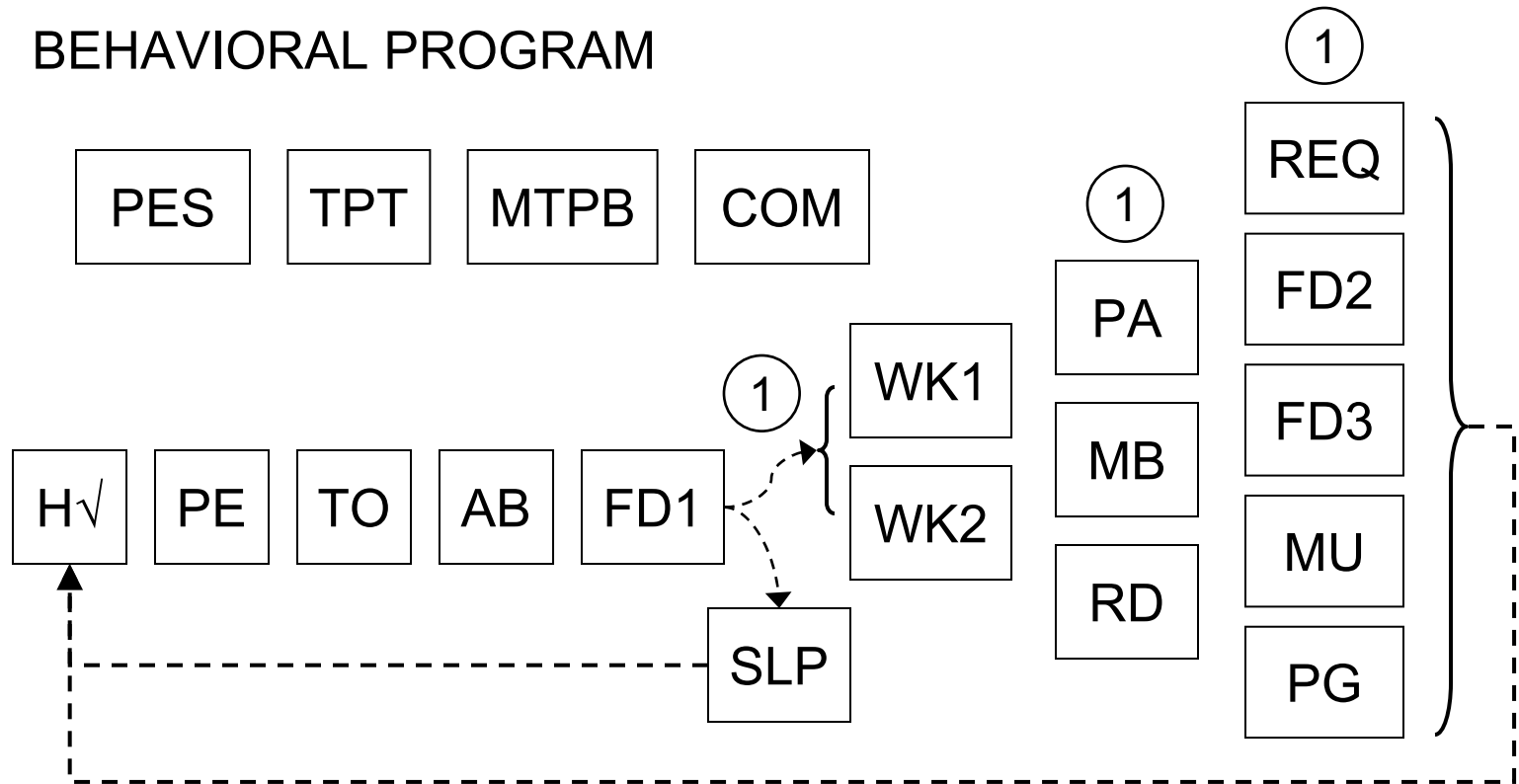
Systematic Replication



Emurian, H.H. (1988). Programmed environment management of confined microsocieties. *Aviation, Space, and Environmental Medicine*, 59(10), 976-980.



BEHAVIORAL PROGRAM



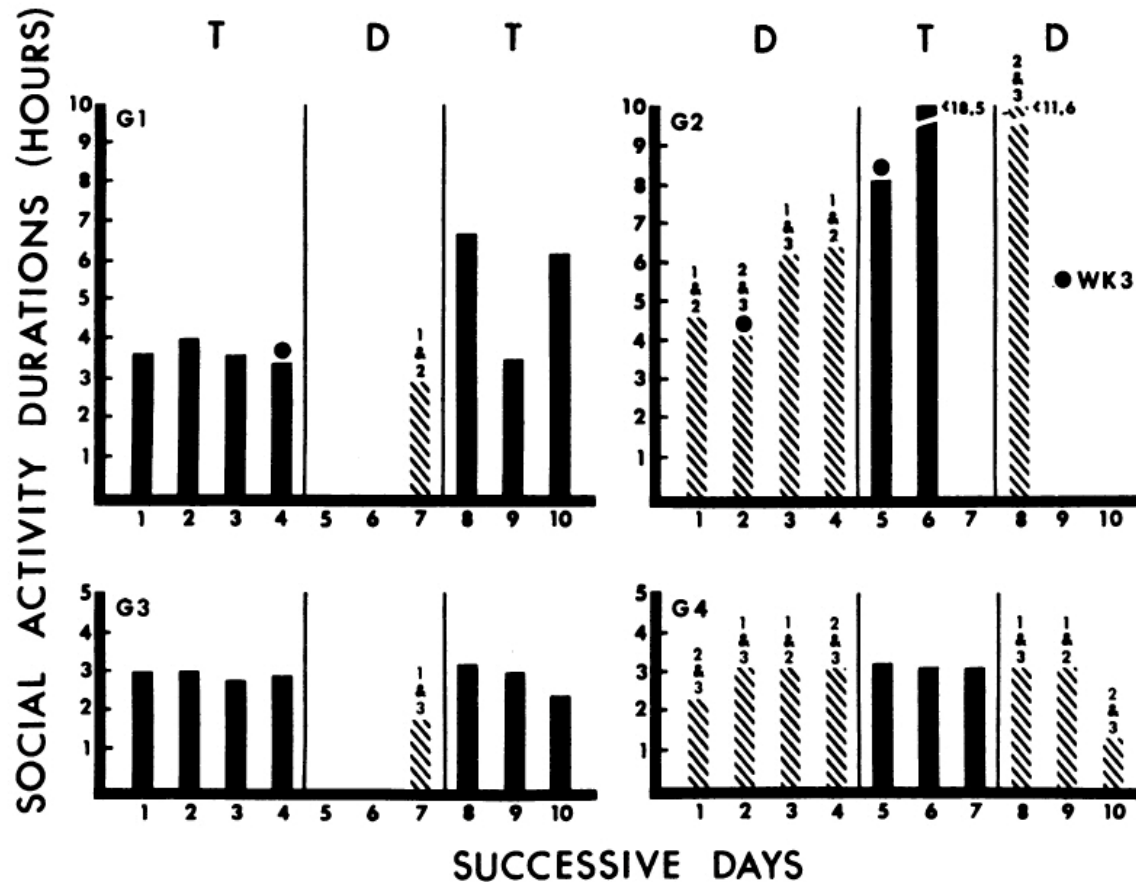


Fig. 2. Social activity durations across successive days of the experiment for all groups. Because no group engaged in more than one social episode per day, the figure bars represent durations of individual episodes. The numbers above dyadic durations identify the two subjects who engaged in the episode. T = triadic condition, D = dyadic condition.

Emurian, H.H., Emurian, C.S., & Brady, J.V. Effects of a pairing contingency on behavior in a three-person programmed environment. *Journal of the Experimental Analysis of Behavior*, 1978, 29, 319-329.



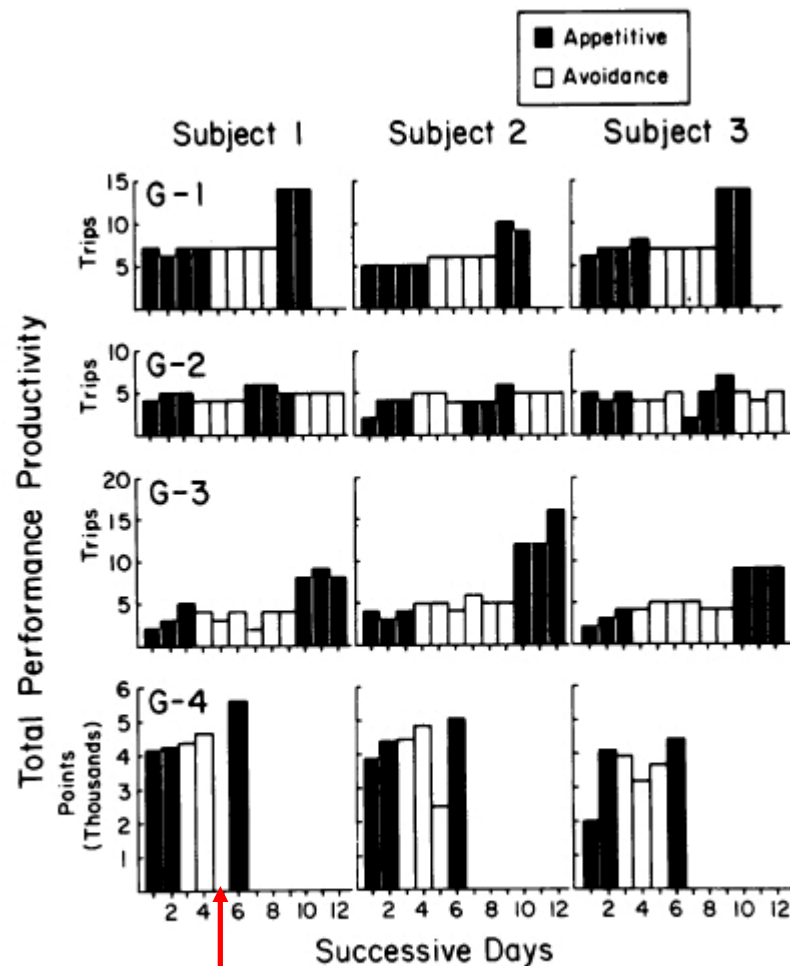


Fig. 10. Total work trips for Groups 1 to 3 and total MTPB points for G4 for all subjects across successive days of the experiment.

Emurian, H.H., Emurian, C.S., & Brady, J.V. Positive and negative reinforcement effects on behavior in a three-person programmed environment. *Journal of the Experimental Analysis of Behavior*, 1985, 44, 157-174.

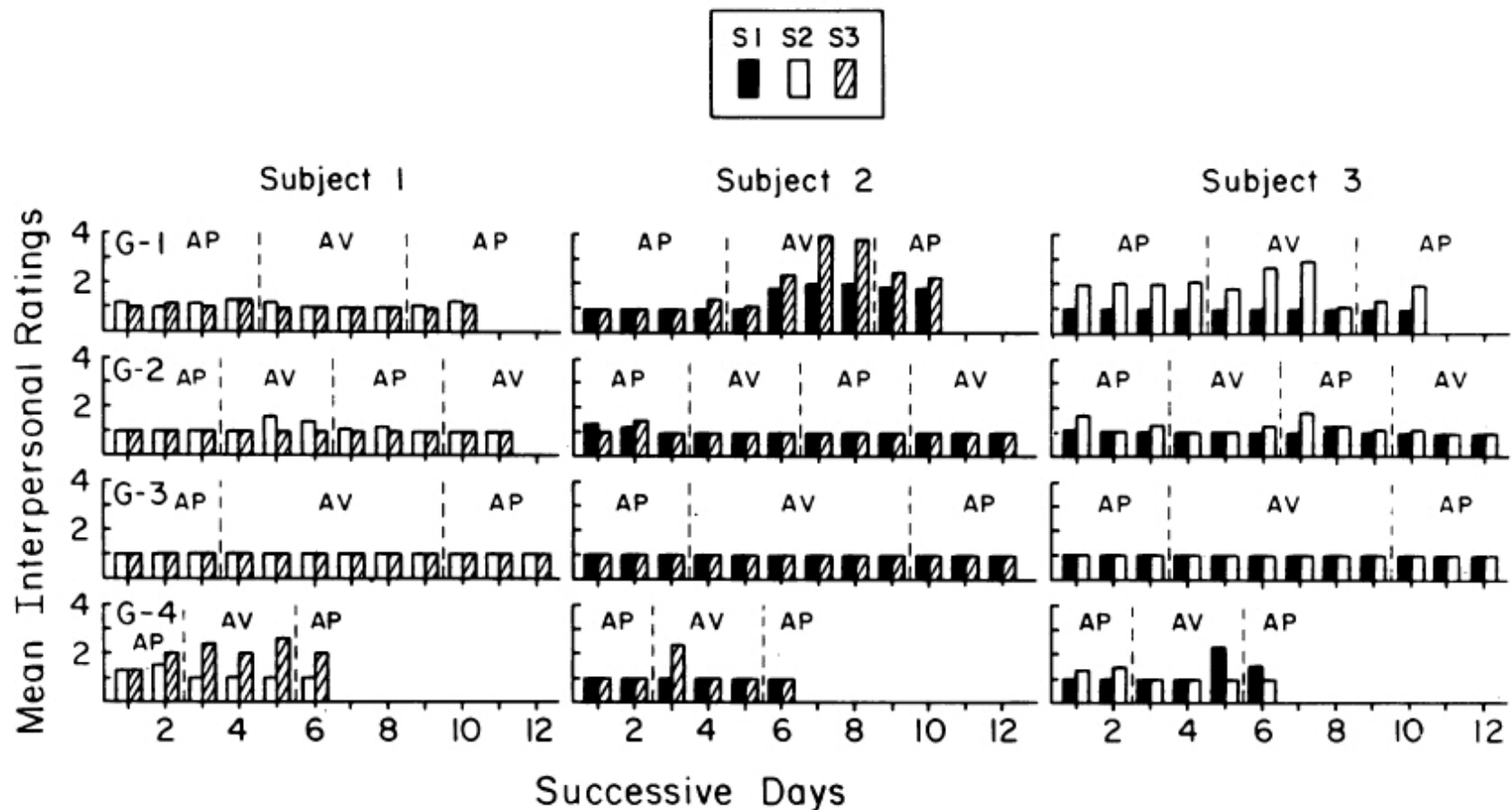


Fig. 5. Mean interpersonal ratings for all subject pairs in each group across successive days of the experiment. 1 = not at all bothered by a subject, and 4 = extremely bothered. AP = appetitive condition, and AV = avoidance condition.

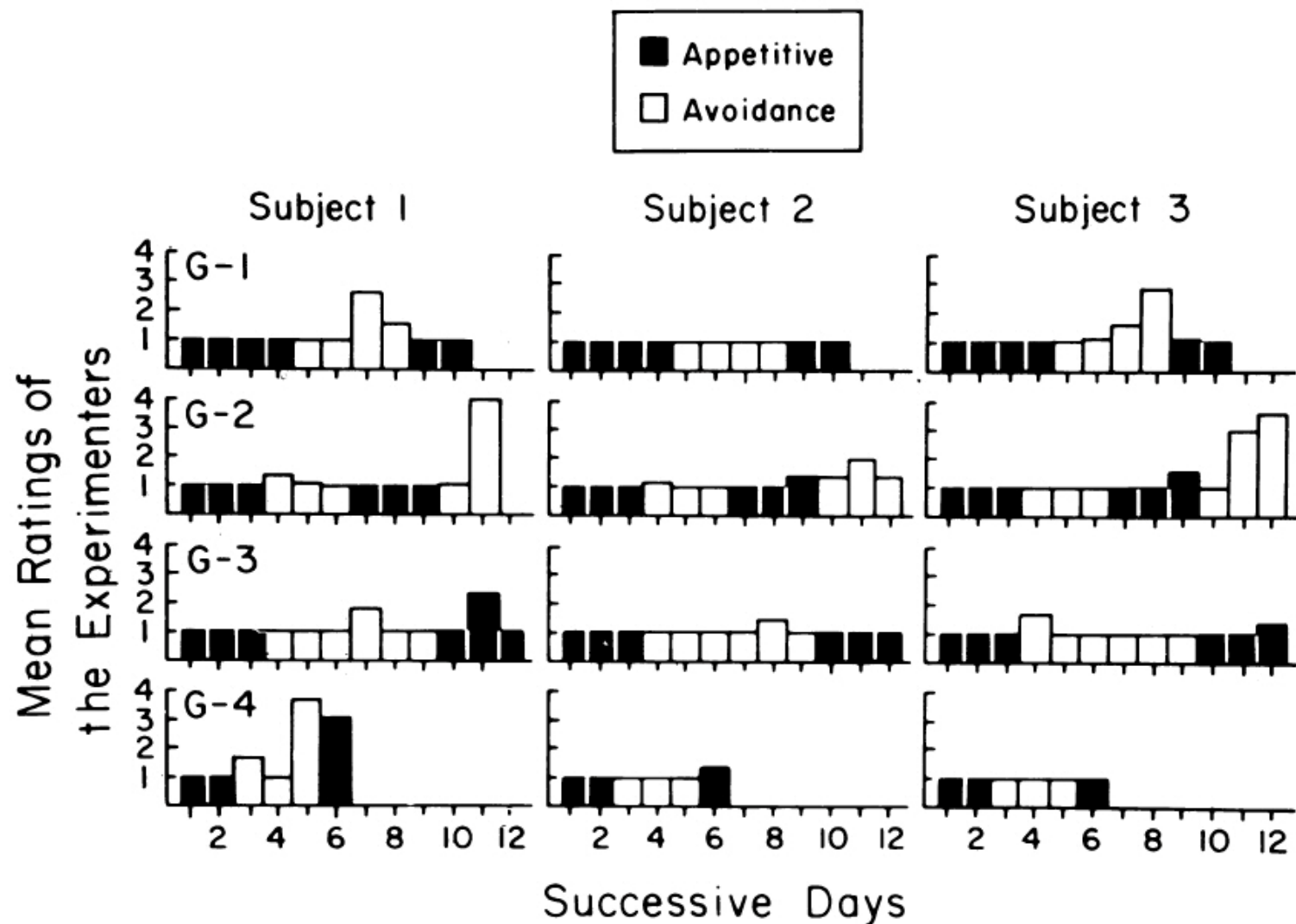
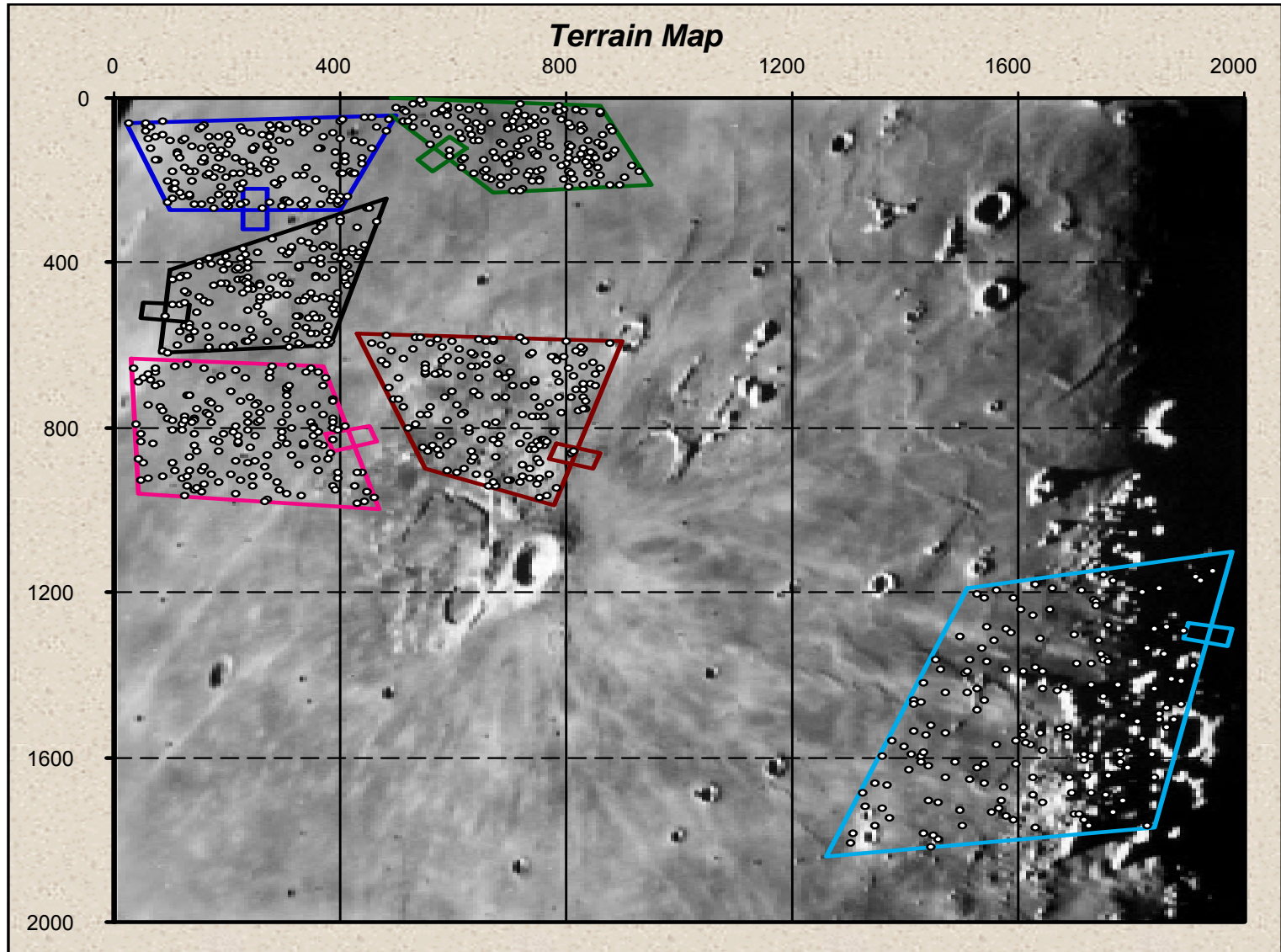


Fig. 4. Mean ratings of the experimenters for all subjects in each group across successive days of the experiment. 1 = not at all bothered by the experimenters, and 4 = extremely bothered.

Planetary Exploration Simulation Task (PES)



The screenshot displays the PES (Planetary Exploration System) interface, which is divided into three main windows: **MAIN (Rover)**, **NAVIGATION (Rover)**, and **COLLECTION TRAY (Rover)**.

MAIN (Rover) Window:

- Rover: MAIN** title bar.
- Five icons representing different rover components: a green antenna, a green antenna, a green antenna, a green antenna, and a green antenna.
- A large blue rectangular area representing the rover's body.
- Two vertical status bars: **F** (Fuel) and **T** (Temperature), both showing a red indicator at the bottom.
- Buttons for **NAV**, **COL**, and **COMS**.
- An **Execute** button and a text input field containing **sr**.
- A status bar showing **WeatherRadar:Deploy:COMPLETE**.
- A **Damage** status bar showing **none**.

NAVIGATION (Rover) Window:

- NAVIGATION (Rover)** title bar.
- Orbiter Track:** 00:03:21 (indicated by a red bar).
- A large grayscale image of the Martian surface showing the rover's position and various craters.
- Buttons for **Center on Vehicle**, **Collect Sample**, and **Clear Scribbles**.

COLLECTION TRAY (Rover) Window:

- COLLECTION TRAY (Rover)** title bar.
- Sample Attributes** section:

 - Sample #: 330
 - Size: Small
 - Weight: 1
 - Shape: Oval
 - Color: Red
 - Zone: Crater

- Totals** section:

 - Total Hits: 0
 - Capacity: 100
 - Load: 5

- Sample Tray** section:

 - A grid of 10 slots, with the top-left slot containing a yellow and red sample icon.

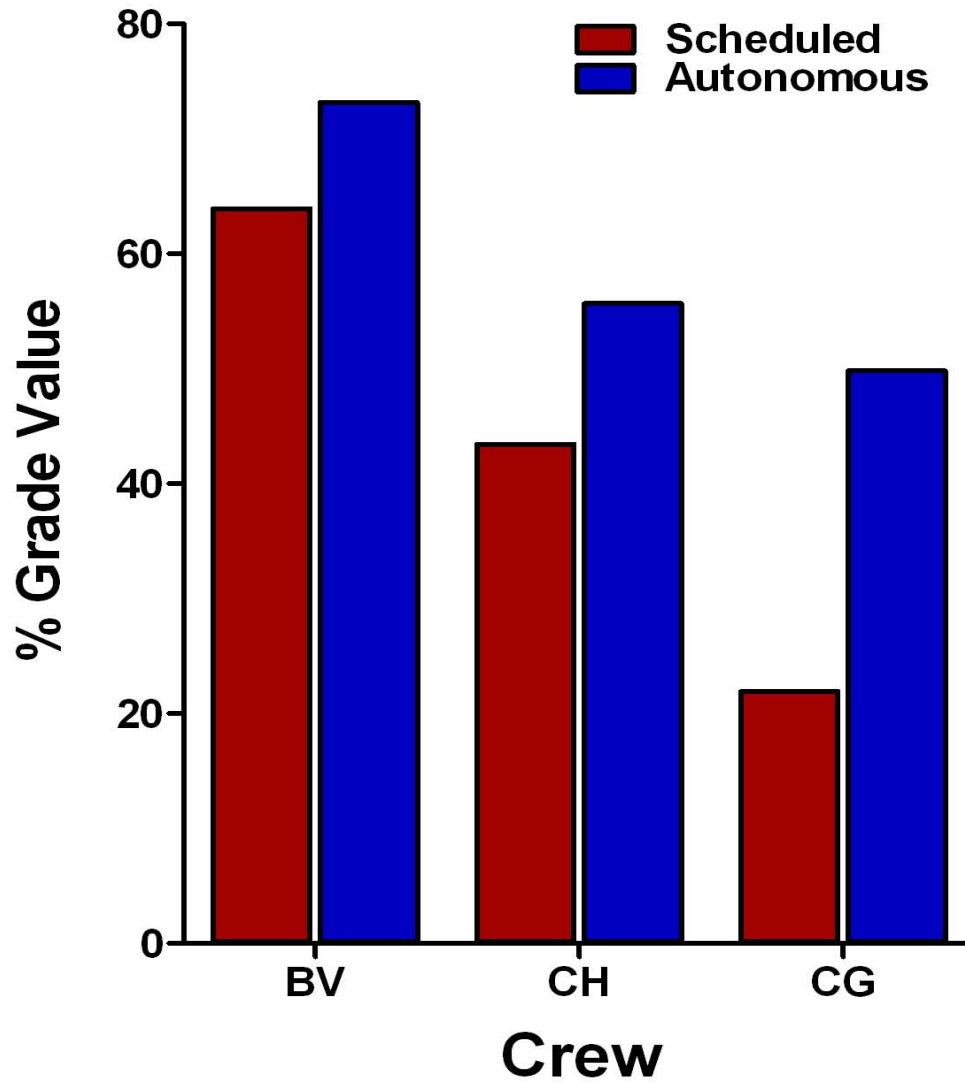
- Sample Test Results** section (empty).

The Windows taskbar at the bottom shows the Start button, the PES application icon, and three open windows: **MAIN (Rover)**, **NAVIGATION (Rover)**, and **COLLECTION TRAY (Rover)**. The system clock indicates 3:55 PM.

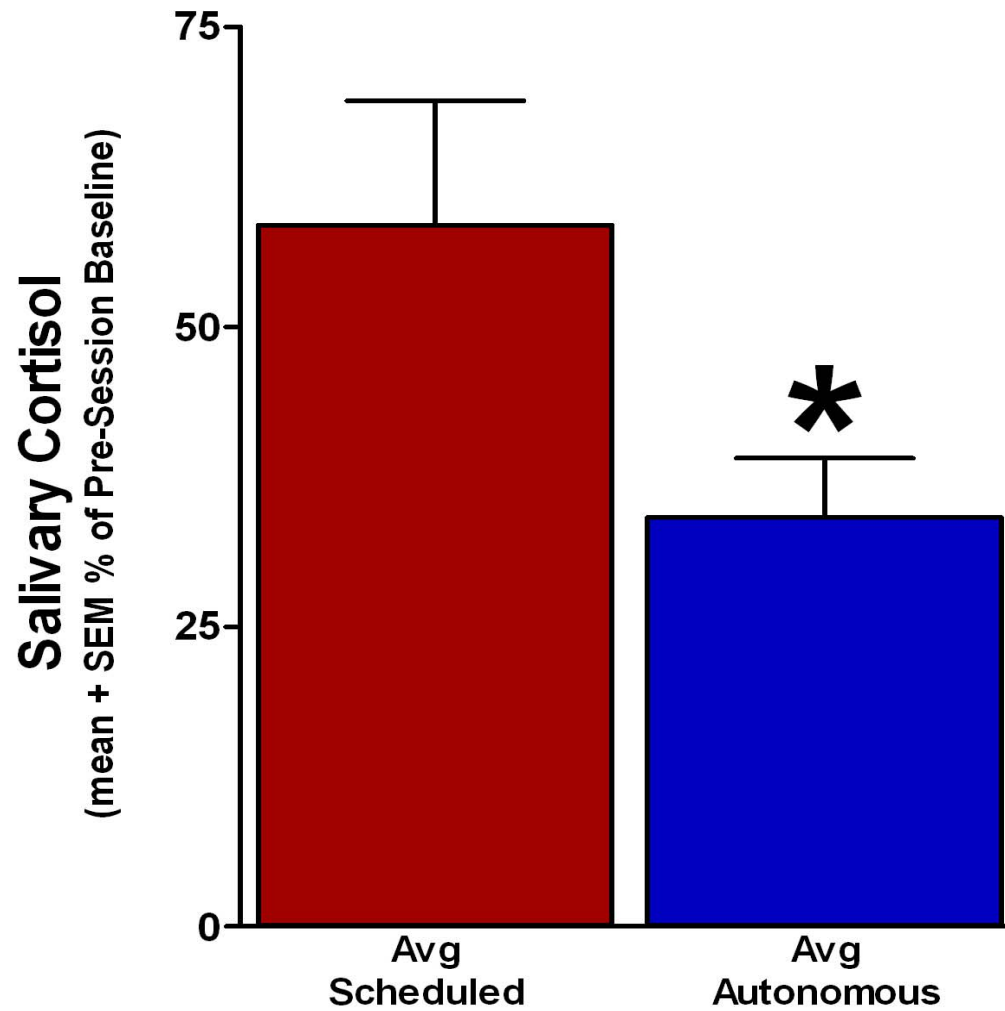




Autonomy Improves Performance



Autonomy Reduces Cortisol Reactivity



Team Performance Task (TPT)

TPT Main - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Resource

Resource

Resource

Barrier4

Barrier7

Barrier9

Target score=0

You are Team Member2
Barrier Reveal Requirement = 250
Team Member1 Score = 0
Team Member2 Score = 0
Team Member3 Score = 0

Team Score = 0

Send a request to reveal a barrier.



TP1 Main - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Resource

Resource

Resource

You hit Barrier1

Barrier2

Barrier3

Barrier6

Barrier7

Barrier8

Barrier9

Target score=1

Send a request to reveal a barrier.
Request

You are Team Member3
 Barrier Reveal Requirement = 4000
 Team Member1 Score = 2
 Team Member2 Score = -6
 Team Member3 Score = 1

 Team Score = -3

TP1 Main - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Resource

Resource

Resource

Team Member1 has requested that you reveal your Barriers.

Barrier2

Barrier3

Barrier6

Barrier7

Barrier8

Barrier9

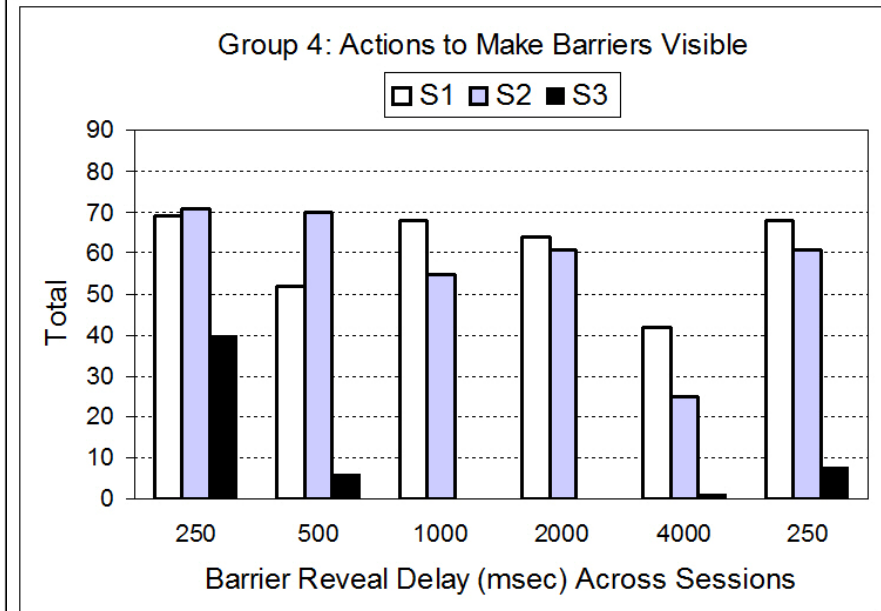
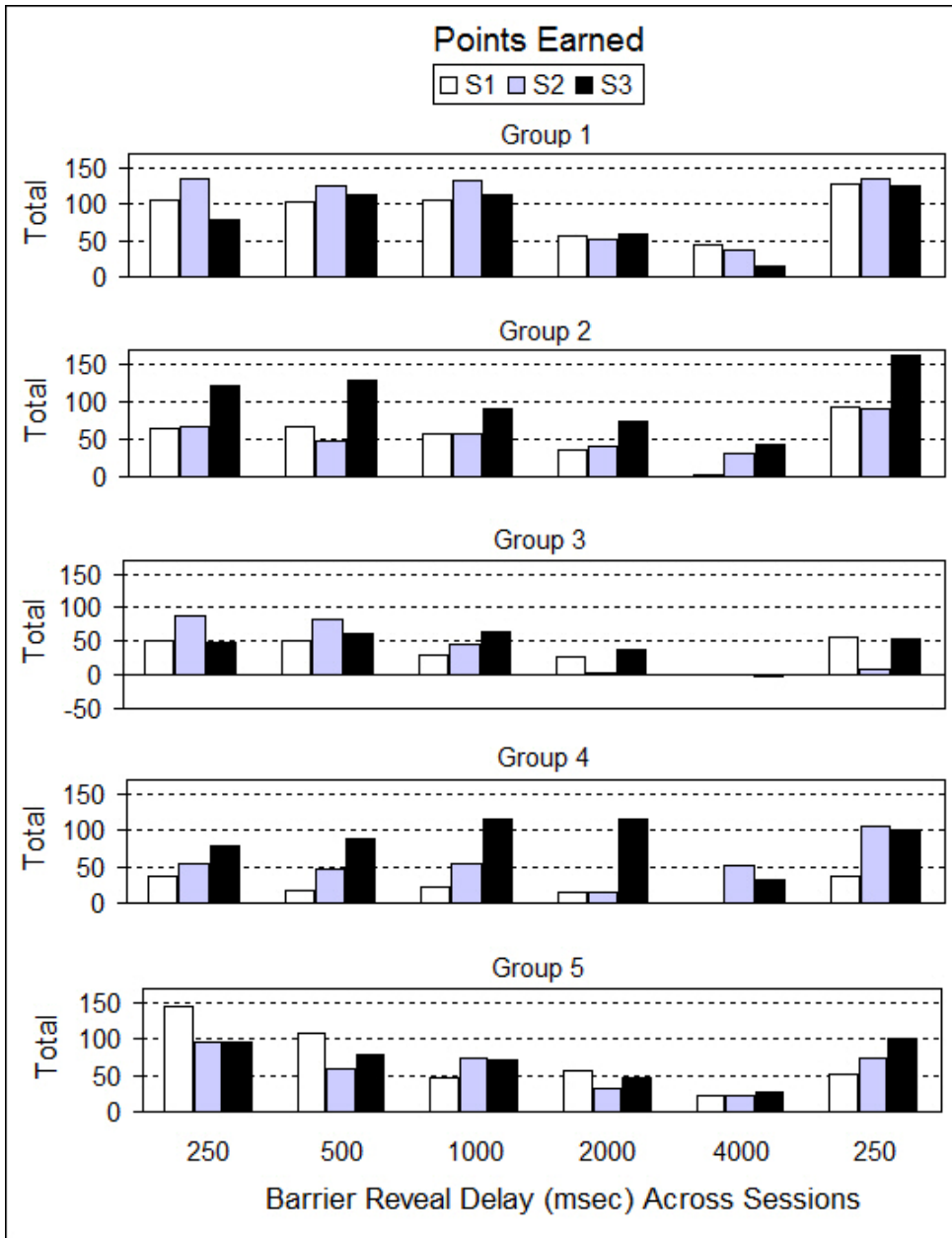
Target score=2

Send a request to reveal a barrier.
Request

You are Team Member3
 Barrier Reveal Requirement = 1000
 Team Member1 Score = 2
 Team Member2 Score = -6
 Team Member3 Score = 2

 Team Score = -2





- What are the effects on individual and crew performances and adjustment of **social contingencies** on high-value activities such as meals and recreation?
 - This question addresses such risks to long-duration spaceflight as human performance failure due to **poor psychosocial adaptation**.



- What are the interactive BP, PES, and TPT **markers** of impending degradation and loss of mission-critical individual and crew skilled performances, and what interventions will reverse such changes and restore acceptable behavioral health?
 - This question addresses such risks as **mismatch** between crew cognitive capabilities and task demands.



- In what ways may the behavioral program implement **alternative work and rest routines** to overcome loss of motivation, social disruption, and degradation in skilled performance?
 - What are the differential effects of autonomous and rule-governed **access** to activity units?



- In what ways may team-oriented tasks such as the TPT as **diagnostic markers** of the status of a crew?
 - Can such tools be adopted to **affirm and maintain social cohesion** and role differentiation and identification among crew members and between crew members and mission control?



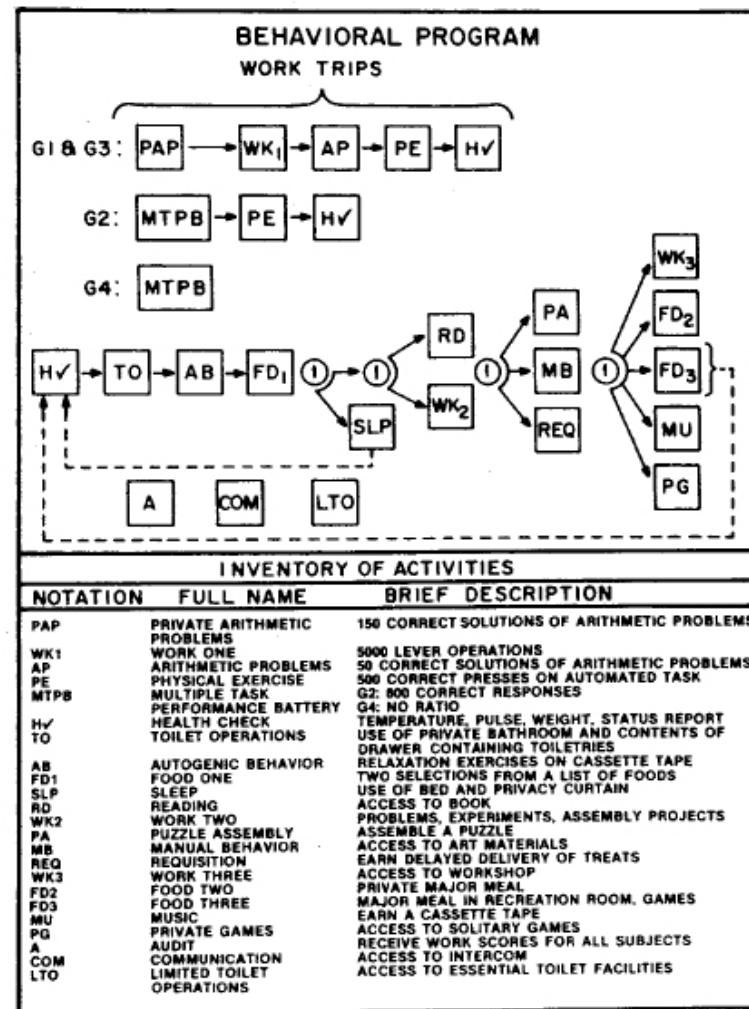
Applications: Which Approach?

Rg 0451u

Form 24 for 06/08/09

Prepping Orlans for EVA

Time	Crew	Ops
06:00-06:10	CDR,FE-3,FE-5	Morning inspection
06:00-06:05	FE-4	Taking biophosphanat pills
06:00-06:05	FE-1	SLEEP - data logging
06:00-06:05	FE-2	SLEEP - data logging
06:05-06:10	FE-1,FE-4	Morning inspection
06:05-06:10	FE-2	Taking biophosphanat pills
06:10-06:40	CDR,FE-1,FE-3, FE-4,FE-5	Post-sleep
06:10-06:35	FE-2	Post-sleep
06:35-07:10	FE-2	Breakfast
06:40-07:30	CDR,FE-1,FE-3, FE-4,FE-5	Breakfast
07:10-07:25	FE-2	Private Psych Conference (Ku+S-band)
07:25-07:30	FE-2	Breakfast
07:30-07:40	FE-4	PHS h/w installation
07:30-07:40	CDR,FE-1,FE-2, FE-3,FE-5	Work prep
07:40-08:05	.	DPC (S-band)
08:05-08:15	CDR,FE-1, FE-4,FE-5	Work prep
08:05-08:45	FE-3	Taking photos of docking probe traces on docking cone (ACP-B) of FGB
08:05-09:20	FE-2	PE CEVIS
08:15-08:45	FE-4, FE-5(--мощь)	Periodic health check



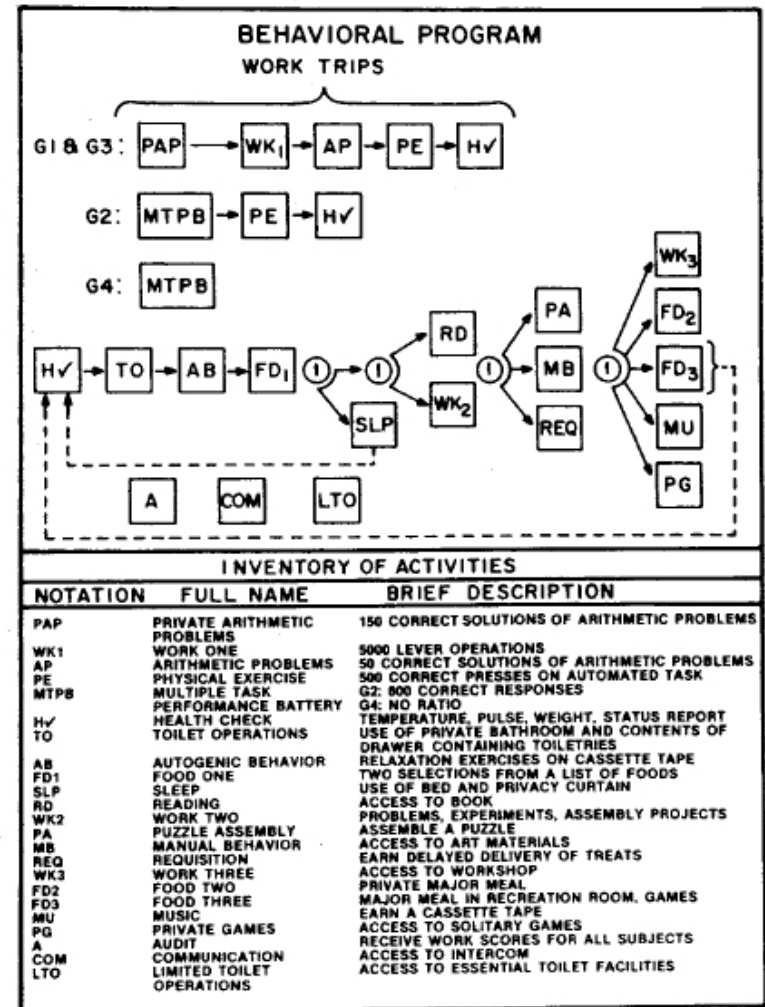
Both approaches have value at different occasions in a mission to Mars.

Rg 0451u

Form 24 for 06/08/09

Prepping Orions for EVA

Time	Crew	Ops
06:00-06:10	CDR,FE-3,FE-5	Morning inspection
06:00-06:05	FE-4	Taking biophosphanat pills
06:00-06:05	FE-1	SLEEP - data logging
06:00-06:05	FE-2	SLEEP - data logging
06:05-06:10	FE-1,FE-4	Morning inspection
06:05-06:10	FE-2	Taking biophosphanat pills
06:10-06:40	CDR,FE-1,FE-3, FE-4,FE-5	Post-sleep
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07:40-08:05	.	DPC (<i>S-band</i>)
08:05-08:15	CDR,FE-1, FE-4,FE-5	Work prep
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08:05-09:20	FE-2	PE CEVIS
08:15-08:45	FE-4, FE-5(--мощь)	Periodic health check



Timeline control → Behavioral program → Timeline control



- Develop evidenced-based principles.
- Behavioral systems management.
- Long-duration simulations and evaluations of this approach are indicated.



- The end result, as stated within NASA's *Behavioral Health & Performance Element*, is to **optimize** the adaptation of the individual and crew to the space environment and **maintain** motivation, morale, productivity, cohesion, and communication.

<http://humanresearch.jsc.nasa.gov/elements/bhp.asp>



