NICK KANAS

HUMANS IN SPACE

The Psychological Hurdles

Springer

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Nick Kanas
University of California, San Francisco (UCSF)
San Francisco, CA, USA

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(Front cover and spine): "Working in space can be an isolating experience. Here a Space Shuttle astronaut tests a safety system during an EVA and is perhaps in a thoughtful frame of mind like that expressed by his imaginary companion. Image of astronaut taken from a NASA/JSC digital image dated 16 September 1994; human face and image of Earth taken from Shutterstock."
(Back cover, left): "For centuries, humans have felt the psychological need to populate the heavens with mythological figures. This 1696 image of the northern celestial constellations is taken from Johann Zahn's *Specula Physico-Mathematico-Historica* and is courtesy of the Nick and Carolynn Kanas collection and *Star Maps: History, Artistry, and Cartography, 2nd ed*. (Nick Kanas, Springer, 2012)."
(Back cover, right): "Teamwork is important for space activities. Here, two astronauts prepare to egress from a Space Shuttle for a joint EVA. NASA/JSC digital image dated 9 February 1995."

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Contents

Acknowledgments

I have always been a "space cadet." Going back to my pre-teen years, I devoured science-fiction books and observed the heavens as an amateur astronomer through my small telescope. As a medical student at the University of California, Los Angeles, School of Medicine, I spent the summer of 1968 working in a NASA-funded sleep research project and the summer of 1969 as a teaching assistant to undergraduates participating in a summer space biology program (where I got to experience several G's on a centrifuge during a field trip to the Ames Research Center and watched the first lunar landing on live television with several of my students). In the fall of 1970, I worked on a special project at the Johnson Space Center. My supervisor, psychologist Bill Feddersen, showed me the ropes, including a chance to experience depressurization in an altitude chamber and periods of weightlessness on the "vomit comet" airplane with an Apollo crew practicing a space procedure. The result of my project was a NASA Technical Memorandum that I wrote with Bill that was published in 1971 and entitled *Behavioral, Psychiatric and Sociological Problems of Long-Duration Space Missions* (N. Kanas and W. Feddersen, NASA TM X-58067, National Aeronautics and Space Administration Manned Spacecraft Center, Houston, Texas). This monograph formed the nucleus of many of my subsequent writings and informed me about important issues that I would later use in my research activities, and I will always be grateful to Bill for this important start in my space-related career.

Prior to the 1990s, NASA was not soliciting psychological studies from extramural sources, but I was fortunate in being invited by Alan Kelly to help him prepare the findings of his Stanford University master's thesis for publication. The study investigated the communication patterns of astronauts and cosmonauts, and the results ultimately were published by peer-reviewed journals in 1992, 1993, and 1994. I am grateful to Alan for involving me in this project. I also was invited to contribute a psychological study for a 135-day space simulation activity sponsored by the European Space Agency (ESA) that was called HUBES, or the HUman BEhaviour Study. My results were published in 1996.

In the early 1990s, NASA decided to solicit psychological studies in preparation for its participation on the International Space Station and Mir. My colleagues at the University of California, San Francisco, and I were awarded two large NASA research grants from

1995 to 2006 that funded empirical work on the psychology and interpersonal interactions of astronauts and cosmonauts in space. I was the Principal Investigator for these two projects, and my team included both American personnel at the University of California, San Francisco, and one of its affiliates, the San Francisco Department of Veterans Affairs Medical Center (the location of my lab). We collaborated with Russian co-investigators at the Institute for Biomedical Problems (IBMP) in Moscow. Our team also was funded by NASA and the National Space Biomedical Research Institute (NSBRI) from 2006 to 2010 to study crewmember autonomy in three space simulation environments on Earth.

These various activities form the core of the information in this book, and I am grateful to my various research colleagues, without whom it could not have been written. On the American side, they are: Pamela Baskin, Alan Bostrom, Jennifer E. Boyd, Ellen M. Grund, Eva C. Ihle, Charles R. Marmar, Thomas Neylan, Stephanie A. Saylor, and Daniel S. Weiss. On the Russian side, they are Vadim I. Gushin, Olga P. Kozerenko, Vyacheslav P. Salnitskiy, and Alexander Sled. Dietrich Manzey (who co-wrote the text book *Space Psychology and Psychiatry* with me), Gro Sandal, and Peter Suedfeld also have been helpful collaborators. Many people working at NASA, ESA, the IBMP and the Russian Federal Space Agency, and the NSBRI also have been supportive on these various projects, and I am grateful for their financial and operational assistance throughout the years. I especially would like to thank Jennifer Boyd, Walt Sipes, and Steve Vander Ark who provided helpful comments to an earlier draft of this book.

Finally, I am grateful to my wife Carolynn, who for over 40 years has supported me in my various space-related projects, many funded and some unfunded. She has accompanied me to some conferences and held the home front while I was away at other conferences or training research subjects in Houston, Moscow, or Europe. Her involvement with this book has been indirect but nevertheless very important.

Preface

With the continued use of the International Space Station, the construction of rockets and space habitats aimed at sending humans to Mars, the advent of space tourism, and the increasing involvement of private enterprise in on-orbit activities, there has been renewed interest in space. This interest has prompted us to look at the impact of space missions on the human psyche and on the interpersonal interactions of the humans on board (both crewmembers and tourists). Using anecdotal reports from astronauts and cosmonauts (the Russian term for their astronauts), and the results from studies conducted in space analog environments on Earth (e.g., the Antarctic, submarines, space vehicle simulators) and during actual missions on orbit, *Humans in Space*: *The Psychological Hurdles* broadly reviews the various psychosocial issues that affect space travelers. These issues not only are discussed with reference to astronauts working today in space, but they also are considered in terms of future travelers such as space tourists, crewmembers going on expeditions to Mars and other planets in the Solar System, and humans who may someday be involved in multigenerational missions to exoplanets around distant stars.

The book is divided into two sections. The first deals with near-Earth missions orbiting our planet or traveling to the Moon and back. Because these missions have actually occurred, what is presented reflects actual reports from space and research conducted in both space and analog environments. The eight chapters in this section deal with psychosocial stressors; psychological, psychiatric, and interpersonal issues; the effects of cultural and language differences; positive effects of space travel; space tourism; and countermeasures for dealing with the psychosocial aspects of the space environment. The second section takes what we know and extrapolates it for future interplanetary and interstellar missions. Its four chapters deal with the effects of increasing autonomy, expeditions to Mars and to the outer Solar System, and interstellar missions. An epilogue sums up the main issues from a psychological perspective.

Humans in Space: *The Psychological Hurdles* is targeted for the general public. It is meant to be of interest to space enthusiasts, workers in space and aviation professions and businesses, amateur astronomers, science-fiction readers, people interested in space advocacy, employees at space agencies and in isolated and confined environments on Earth,

and members of the general public who are interested in space travel and the human side of long-duration space missions. Other targeted audiences include students and professors in university psychology, social science, and medical programs; and psychologists, physicians, astronomers, and other scientists interested in human space travel. The psychological hurdles are meant to be identified and jumped over as our experiences in space develop and psychosocial problems are resolved. Let's begin the journey!

San Francisco, CA
February 10, 2015

Nick Kanas, M.D

Abbreviations

CO_2	Carbon dioxide
CRM	Crew Resource Management
CSA	Canadian Space Agency
Desert RATS	Desert Research and Technology Studies
ESA	European Space Agency
EVA	Extravehicular activity
EXEMSI	Experimental Campaign for the European Manned Space Infrastructure
FKA	Russian Federal Space Agency
FAA	Federal Aviation Administration (USA)
FIRO-B	Fundamental Interpersonal Relations Orientation–Behavior
GES	Group Environment Scale
HMP	Haughton-Mars Project
HTO	Horizontal take-off
HUBES	HUman BEhaviour Study
IBMP	Institute for Biomedical Problems
ICE(s)	Isolated and Confined Environment(s)
ISEMSI	Isolation Study for European Manned Space Infrastructure
JSC	Johnson Space Center
LOFT	Line-oriented flight training
MARS 500	500-day Mars simulation project
MRAB	MiniCog Rapid Assessment Battery
NASA	National Aeronautics and Space Administration
NASDA	Japanese National Space Development Agency
NEEMO	NASA Extreme Environment Mission Operations program
NSBRI	National Space Biomedical Research Institute
PCVQ	Portraits of Crew Values Questionnaire
POMS	Profile of Mood States
PSPA	Personal Self-Perception and Attitudes test
RAIR	Ram-Augmented Interstellar Rocket

RKA	Russian Federal Space Agency
RLV	Reusable launch vehicle
SFINCSS	Simulation of a Flight of International Crew on Space Station
SFRM	Space Flight Resource Management
sRLV	Suborbital Reusable Launch Vehicle
VIIP	Visual impairment and elevated intracranial pressure
VTO	Vertical take-off
WES	Work Environment Scale
WinSCAT	Spaceflight Cognitive Assessment Tool for Windows

Section I

Near-Earth On-Orbit and Lunar Missions