Enhancing the Meaningfulness of Work for Astronauts on Long Duration Space Exploration Missions

Thomas W. Britt; Anton Sytine; Ashley Brady; Russ Wilkes; Rebecca Pittman; Kristen Jennings; Kandice Goguen

INTRODUCTION: Numerous authors have identified the stressors likely to be encountered on long duration space exploration missions (e.g., to Mars), including the possibility of significant crises, separation from family, boredom/monotony, and interpersonal conflict. Although many authors have noted that meaningful work may be beneficial for astronauts on these missions, none have detailed the sources of meaningful work for astronauts and how these sources may differ between astronauts. The present article identifies how engagement in meaningful work during long duration missions may mitigate the adverse effects of demands and increase the potential for benefits resulting from the missions.

METHOD: Semistructured interviews were conducted with nine NASA personnel, including astronauts, flight directors, and flight surgeons. Questions addressed sources of meaning for astronauts, characteristics of tasks that enhance vs. detract from meaning, and recommendations for enhancing meaning.

RESULTS: Personnel mentioned contributing to humanity and the next generation, contributing to the mission, and exploration as the most meaningful aspects of their work. Characteristics of tasks that enhanced meaning included using a variety of skills, feeling personal control over their schedule, autonomy in the execution of tasks, and understanding the importance of the experiments conducted on the mission. Top recommendations to sustain meaning were insuring social needs were met through such activities as the strategic use of social media, giving astronauts autonomy as well as structure, and conducting training during transit.

DISCUSSION: Implications are addressed for tailoring meaning-based interventions for astronauts participating on long duration missions and assessing the effectiveness of these interventions.

KEYWORDS: long duration missions, astronauts, meaningful work, interventions.

Numerous authors have noted the physical and psychological demands that will be placed on astronauts participating in long duration space exploration missions (LDSEM) to Mars and other locations.[9] The psychological demands likely to be encountered during LDSEM include life-threatening situations, confinement, lack of privacy, boredom, interpersonal conflict, and family separation, among others. In addition, recent analog studies of individuals participating in long duration periods of isolation and confinement, including the MARS 500 simulation, indicate that reports of overall stress may be higher in long duration missions than in prior space missions.[1] The demands of LDSEM have the potential to create the development of significant mental health symptoms that may compromise the astronaut's health, well-being, and performance. The present article addresses how engagement in meaningful work throughout the LDSEM may decrease the demands associated with boredom and monotony, as well as buffer astronauts from the negative consequences associated with other stressors likely to be encountered on these missions.

Employees consider their work to be meaningful when it serves an important purpose or is otherwise seen as significant.[7] Prior research has examined the importance of meaningful work in the motivation, health, and performance of employees in diverse occupations.[6,10] Britt and Bliese[5] found that engagement in meaningful work buffered military personnel from

deployment-related stressors, including lack of sleep, living in an austere environment, and family separation.[3] Prior authors have noted, but not empirically examined, the importance of meaningful work in the adjustment of astronauts during difficult missions.[9,11]

Employees who believe they are involved in meaningful work will be more likely to proactively address the demands that are encountered and to view these demands as challenges to be mastered, as opposed to threats to well-being and performance.[8] Astronauts have been described as action-oriented individuals who have high achievement motivation and enjoy dealing with challenges that arise. Therefore, astronauts who believe they are involved in meaningful work will not only be less likely to experience negative outcomes associated with the demands likely to be encountered on LDSEM (e.g., mental health symptoms, boredom, performance errors), but should also experience positive consequences from successfully mastering the challenges in executing mission-relevant tasks under difficult operational conditions.[12]

The present study examined the role of meaningful work in the adjustment and performance of astronauts on long duration missions by interviewing NASA personnel (e.g., astronauts, flight directors, flight surgeons). Personnel responded to questions regarding the sources of meaning in their work, characteristics of tasks that contribute vs. detract from meaning, and recommendations for enhancing meaning on long duration missions. Responses to the interview questions were coded and summarized, and the implications of the results for interventions to enhance meaning during long duration missions are discussed.

METHODS

Subjects

Interviews were conducted with nine Subject Matter Experts (SMEs) who have had direct involvement with space missions through primary or supporting roles or who had experiences with analog environments. These included individuals with a variety of job titles who offered unique perspectives on the experience of astronauts and what methods could be used to enhance the meaning of their work. The job titles of individuals who were interviewed included: two former astronauts, a crew psychologist, an operations planner, a flight director, a crew trainer, an analog environment researcher, a capsule communicator, and an Antarctic explorer.

Procedure

Participants were interviewed using a semistructured protocol via conference call. Interviews lasted between 30 and 60 min. At the start of each call, the interviewee was informed of the purpose of the study being conducted and their role in the study. They were further informed that while their responses would be used in identifying themes regarding meaningful work, direct quotations and their names would not be provided in the final report. Therefore, the responses were anonymous.

The interviews were not recorded; however, graduate research assistant(s) took detailed notes of the responses to be used for further analysis.

For the present study we asked four questions related to meaningful work. We asked what the participants found meaningful about their work, characteristics of tasks that contributed to meaningful work, factors that decreased meaningful work and engagement, and strategies to increase engagement in meaningful work. Furthermore, the interviews were conducted in a fluid manner, such that the interviewer would sometimes move to different questions as the topics came up rather than following a standard pattern of proceeding with each question in order. This allowed the interviewer to probe thoughts or comments that were brought up with additional questions as these topics arose naturally.

Analysis

A coding scheme was developed to better understand common themes that emerged from the interviews. Interviews were examined in two stages. In the first stage, major themes that paralleled the academic literature on meaningful work, as well as any novel comments or discussions that were mentioned by the SMEs, were identified.

Within each of these major categories, there were between 6 and 12 subcodes. In the second stage of processing, the interviews were reexamined for more thorough coding. Each interview was screened for whether or not a code appeared in the interview transcript. If the code did appear, text that exhibited the code was marked. Then all text passages that were marked as exhibiting a particular code were combined into a final document, giving the number of SMEs who mentioned the code and examples of that code being discussed. We then collapsed the original codes into broader categories for each of the four questions.

RESULTS

Table I provides a summary of the seven major sources of meaning identified by the respondents. The most frequently endorsed categories reflected performing challenging work that required solving a problem or fixing an issue that came up with an experiment and making personal contributions to the success of the overall mission. The next most frequently mentioned categories included doing work that was relevant to the individual's own skills and abilities, and the belief his or her work contributed to humanity as well as to the scientific curiosity of the next generation of potential space explorers. Finally, a smaller number of personnel highlighted learning new skills and helping to carry out experiments that were unique to the space environment.

The six themes that emerged in response to the question addressing the characteristics of tasks that contribute to meaningful work are provided in **Table II**. The most frequently endorsed responses reflected having personal control and autonomy over the work that was conducted, and having the

Table I. Number of Interviewees and Sources for What They Found Meaningful About Their Work.

THEME	N
Challenging, problem solving, fixing something (equipment, experiments)	7
Contributions to the mission	7
Personal interest in the work: relevant to own skills, knowing importance of their work, and performance relevant to others	6
Contributing to humanity/humankind	6
Contributing to next generation (e.g., students)	4
Learning new skills (e.g., technical, professional development)	3
Being involved in important science experiments that can only be done in space	3

There were *N* = 9 respondents.

Table III. Number of Interviewees and Reported Factors Which Decreased Meaningful Work and Engagement.

THEME	N
Lack of/limited communication/explanation regarding tasks or experiments	6
Misperceptions between ground control and crew	4
Combination of decrease in novelty and time away from family	4
False praise, nonspecific praise	3
Nonmotivated team member "infecting" other team members	3
Repeated maintenance tasks (e.g., changing air filters)	3
When things had not been planned out and they got afterthought jobs	2
No separation of work and life; technically no separation	2
Change in roles during crew changeover (e.g., was leader, now follower)	1

There were *N* = 9 respondents.

opportunity to be involved in a variety of tasks that used a variety of skills to offset the boredom and monotony that can sometimes occur on missions. A number of interviewees also mentioned the importance of understanding the purpose and importance of the experiments that were being done on a given mission, as well as being given specific feedback that reflected a recognition of how their work contributed to the successful completion of experiments and the broader mission.

The nine themes that emerged in response to the question addressing factors that decreased perceptions of meaningful work are identified in **Table III**. The responses of the interviewees were more diverse in response to this question and often reflected the absence of factors that were identified as contributing to meaningful work in the prior question. The most frequently endorsed factors that decreased meaningful work centered on the quality and genuineness of the information received regarding experiments conducted during the mission and the broader mission goals. Interviewees also cited the repetition of maintenance tasks and tasks that did not appear to have been properly thought out as decreasing meaning. Finally, some interviewees noted a lack of meaning in tasks when the novelty of the mission had decreased and time away from the family had increased, and when there was a lack of separation between their work and nonwork life on the mission.

Interviewees were asked to recommend different strategies that would be most beneficial in increasing engagement and meaningful work during LDSEM. As seen in **Table IV**, the

Table II. Number of Interviewees and Reported Characteristics of Tasks Which Contribute to Meaningful Work.

THEME	N
Personal control over their schedule, greater autonomy in execution of task	6
Task variety/variety of skills/not monotonous	6
Understanding the purpose and importance of the experiment; how their involvement contributes to the overall success of the experiment	5
Given specific feedback by the principal investigator and ground control; recognition for task performance	4
Understanding how what they are doing contributes to the big picture	3
Personal involvement in shaping mission goals before the mission	1

There were *N* = 9 respondents.

respondents' answers fell into six broad themes. The most frequently mentioned recommendations fell under the Social Needs/Contact theme. Specific recommendations in this category all highlighted the social connections between the astronauts and their families, the broader community, and fellow crewmembers. Specific recommendations included the incorporation of real-time social media for astronauts who wanted to stay connected with a broader community and ways for astronauts to stay connected with their family, such as through private conversations and involving the family in the mission.

The next most frequent category of recommendations addressed the timing of training and logistics for when tasks were scheduled on the mission. Specific recommendations included spacing out training during the mission and spreading out important tasks across the crew and the mission. Respondents also highlighted the importance of having the crew on a schedule while also having flexibility in the scheduling by giving the crew a broader amount of time to have tasks completed.

The next category of recommendations referred to the content of the training and skills to be developed on the mission. Here respondents emphasized the importance of astronauts learning new skills during the mission (e.g., medical skills, mental health first aid training) and cross-training on skills that were a strength of each astronaut. Personnel also highlighted the importance of being able to make mistakes and potentially use errors as points for discussion among team members. This section also addressed learning to deal with the boredom that is likely to occur on long duration missions.

The final three categories were also mentioned by a majority of the respondents and emphasized the importance of selecting members of the team participating in the mission based upon unique skills for the tasks that will be required, ensuring the crew has autonomy over the methods used to accomplish assigned tasks, and supporting the morale of the crew through multiple free time options and the use of humor to break up otherwise monotonous communications and procedures. The recommendations from the six broad themes were in line with interviewee responses to the questions surrounding the sources of meaningful work, qualities of meaningful tasks, and factors that decreased the meaning of tasks.

Table IV. Number of Interviewees and Strategies to Increase Engagement and Minimize Boredom.

MAJOR CATEGORY/THEME	N
Social Needs/Contact	8
Real time social media (but not a requirement for astronauts)	7
Private conversations with family (not on radio)	3
Use virtual reality, so that astronauts can be with their family virtually	2
Have social rituals that increase cohesion (e.g., meals together)	1
Make family more integrated with work (family is aware of what astronaut is doing)	1
Training/Logistics/Daily Schedule	7
Conduct training in transit so it occurs closer to actual performance	4
Spread out important tasks across the crew and across the mission	3
Ensure crew is on a schedule (e.g., eating meals, free time, and sleep); some structure desirable, especially when a lot of down time	3
Keeping busy (make sure long work day busy)	2
Ensure training is relevant to the mission	2
Ensure in-transit goals are connected to the success of the overall mission	1
In addition to a daily schedule, have broader time periods for task completion	1
Space out training; not separated from family a lot right before they leave	1
Training Content/Skills	6
Encourage astronauts to learn new skills (e.g., basic medical skills), cross-train one another, preparing for contingencies that hopefully do not happen	3
Track mistakes/errors, talk about why they are occurring (assumes freedom to make mistakes)	3
Have crewmembers learn how they best deal with boredom before the mission	2
Have crew trained in basic psychological knowledge (perhaps mental health first aid; therapeutic training)	1
Team Composition Recommendations	5
Building teams with tasks in mind (not just randomly selected members); ensure different team roles/mix of people; picked to specify different roles	5
Crew Autonomy During Mission	5
Provide autonomy for astronauts: provide them with a list of things to do and have them do them (more tasks "flexible" that can be done at any time)	5
Supporting Crew Morale	5
Free time options (e.g., encourage hobbies, personal experiments)	4
Use of humor (e.g., ground control sends funny jokes embedded in tasks)	2
Vary communication between ground control and crew (e.g., vary voices doing the communicating, different words to convey same meaning)	2
Surprises embedded with equipment for tasks (e.g., Easter eggs)	1

There were *N* = 9 respondents.

DISCUSSION

The results of the present study provide insights into what NASA and personnel participating in analog operations find most meaningful about their work and provide potential interventions for sustaining meaning on difficult long duration missions. Responses to the items addressing sources of meaning and characteristics of tasks that are meaningful highlight the importance of astronauts knowing the contributions they are making to all aspects of the mission, as well as the contributions they are making to humankind and the next generation. The importance of task significance and doing work that benefits others have been emphasized in prior investigations of meaningful work.[7] Furthermore, the responses of the personnel in the present study illustrate characteristics that detract from meaningful work, which include being given incomplete information about the task at hand and the monotony that comes from doing repeated tasks that lack variety.[9]

Understanding the determinants of meaningful work provides mission support personnel with potential interventions to enhance meaning during LDSEM. Respondents provided a number of recommendations for increasing engagement and perceptions of meaning. In general, the participant responses highlighted the importance of timing interventions to increase perceptions of meaningful work at those mission points where perceptions of monotony increase. The responses also indicate the benefits that will result from any interventions which increase the perception of a greater connection between the astronaut and his or her family (e.g., the potential for virtual reality to bring the family to the astronaut, the family being briefed on the importance of what the astronaut is doing). Ensuring that an astronaut's social needs are addressed during these missions is consistent with the importance of social belonging to individuals.[2]

Future research is needed to examine the effectiveness of different interventions designed to increase meaning and decrease boredom among astronauts participating in LDSEM. Different personnel in the present study identified different sources of meaning for participating in LDSEM, thereby highlighting the importance of tailoring interventions to enhance meaning to increase sources of meaning unique to each astronaut. The administration of interventions that increase meaning should positively influence the mental health and well-being of astronauts participating in these difficult missions and increase the probability of perceived benefits and psychological growth during and following the completion of the mission.[4]

ACKNOWLEDGMENTS

Authors and affiliations: Thomas W. Britt, M.A., Ph.D., Anton Sytine, B.S., M.S., Ashley Brady, B.S., Russ Wilkes, B.S., Rebecca Pittman, B.S., Kristen Jennings, M.S., Ph.D., and Kandice Goguen, B.S., M.S., Clemson University, Clemson, SC.

REFERENCES

1. Basner M, Dinges DF, Mollicone D, Ecker A, Jones CW, et al. Mars 520-d mission simulation reveals protracted crew hypokinesis and alterations of sleep duration and timing. Proc Natl Acad Sci U S A. 2013; 110(7): 2635–2640.

2. Baumeister RF, Leary MR. The need to belong: desire for interpersonal attachments as a fundamental human motivation. Psychol Bull. 1995; 117(3):497–529.

3. Britt TW, Adler AB. Stress and health during medical humanitarian assistance missions. Mil Med. 1999; 164(4):275–279.

4. Britt TW, Adler AB, Bartone PT. Deriving benefits from stressful events: the role of engagement in meaningful work and hardiness. J Occup Health Psychol. 2001; 6(1):53–63.

5. Britt TW, Bliese PD. Testing the stress-buffering effects of self engagement among soldiers on a military operation. J Pers. 2003; 71(2):245–265.

6. Dik BJ, Byrne ZS, Steger MF, editors. Purpose and meaning in the workplace. Washington (DC): American Psychological Association; 2013.

7. Grant AM. The significance of task significance: job performance effects, relational mechanisms, and boundary conditions. J Appl Psychol. 2008; 93(1):108–124.

8. Parker SK, Bindl UK, Strauss K. Making things happen: a model of proactive motivation. J Manage. 2010; 36(4):827–856.

9. Peldszus R, Dalke H, Pretlove S, Welch C. The perfect boring situation—addressing the experience of monotony during crewed deep space missions through habitability design. Acta Astronaut. 2014; 94(1):262–276.

10. Rosso BD, Dekas KH, Wrzesniewski A. On the meaning of work: A theoretical integration and review. Res Organ Behav. 2010; 30:91–127.

11. Stuster J. Behavioral issues associated with long duration space expeditions: review and analysis of astronaut journals (Experiment 01-E104; Journals). Houston (TX): NASA/Johnson Space Center; 2010.

12. Suedfeld P, Brcic J. Resolution of psychosocial crises associated with flying in space. Acta Astronaut. 2011; 69(1–2):24–29.