
2015 Behavioral Health and Performance Standing Review Panel

Status Review for:

The Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders, The Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team, and The Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload

Final Report

I. Executive Summary and Overall Evaluation

The 2015 Behavioral Health and Performance (BHP) Standing Review Panel (from here on referred to as the SRP) met for a site visit in Houston, TX on December 2 - 3, 2015. The SRP received a status update on the Risk of Adverse Behavioral Conditions and Psychiatric Disorders (BMed Risk), Risk of Performance Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team (Team Risk), and Risk of Performance Errors Due to Fatigue Resulting from Sleep Loss, Circadian Desynchronization, Extended Wakefulness, and Work Overload (Sleep Risk).

The SRP continues to be favorably impressed with the leadership provided by BHP Element Scientist Dr. Lauren Leveton, the efforts of her team of scientists, and the substantial number of ongoing projects in analog settings and in university and other research laboratories. Efforts to develop additional polar analog sites for ongoing and new projects are other positive features. The SRP applauds the addition of Dr. Tom Williams to the BHP team as senior scientist in charge of laboratory integration and Dr. Erin Flynn-Evans to the Sleep group. Completion of the astronaut job analysis for current and future space exploration missions constitutes significant progress toward better understanding of individual and team demands. Likewise, the development of the Robotics On-Board Trainer (ROBoT) constitutes a significant step toward development of ecologically valid performance measures. Also, installation of the new lighting system on the International Space Station (ISS) is an accomplishment that will pay dividends in terms of astronaut health and performance, and serves as a testament to both the scientific acumen and the effectiveness of the BHP.

The BHP Element supports a large number of studies across the BMed, Team, and Sleep areas. In general, these projects are proceeding on schedule, with new projects begun in 2015 and others that will commence in 2016. However, the SRP recommends that the BMed area better prioritize the topics solicited for future NASA Research Announcements (NRAs); this could be facilitated by increased input from internal NASA clinical personnel to help make these decisions. The emergence of irritability, anxiety, agitation, and mood changes in astronauts over time are key targets for future research, in conjunction with personalized countermeasures and treatment interventions based on individual characteristics. The SRP notes that the long-standing Optical Computer Recognition project will run its course over the next year, and off the shelf facial recognition technologies will be evaluated. However, questions arise whether facial recognition technologies in general are the most effective means of monitoring emotional states on long-duration exploration missions. Greater interaction between BHP and the Human Health Countermeasures (HHC) Element including pharmacology is encouraged.

The SRP considers individual personality traits to be an important aspect of team composition, but feels that an increased focus on training people to work together would also prove fruitful. This training would be based in part on team members understanding the personality characteristics of the individuals with whom they are working. The SRP appreciates the work on the evolution of a team over the long term, and feels that team training should be informed as well by efforts to understand this evolution. In a similar vein, the SRP felt that attention must be given to the possibility that intimate (e.g., romantic) relationships may be formed among crew members during long-duration exploration missions that are expected to last up to three continuous years. If such relationships, although unintended, should develop there is a strong potential for a negative impact on overall team performance.

Leadership dynamics at team and multiple team system (MTS) levels needs greater attention, particularly in light of communication delays and increased autonomy in future long-duration exploration missions. The effects of a stable crew vs. rotating mission control teams and associated power dynamics needs greater attention as well.

Based on the 2014 recommendation of the SRP, the SRP is pleased to note the new or extended engagement with military research personnel and/or established military laboratories to leverage their prior and current work on mathematical sleep/performance prediction modeling, sleep/alertness medications, the effects of small team isolation (i.e., submariner research), and potential solutions for novel nutrition or food stability issues (i.e., Army nutritional programs).

Research on individualized sleep medication administration protocols is a positive feature of the Sleep portfolio. Greater attention to the effects of stimulant medications is recommended since at least some categories of these medications are being utilized in space operations but are often not mentioned in the research portfolio. The Sleep team is encouraged to assess the relationship between sleep symptoms and other somatic symptoms, as well as the effects of sleep loss on emotional regulation and team interactions. When considering the impact/efficacy of existing or new medications, input from clinical pharmacology would be useful as well. The SRP recommends de-emphasizing single nucleotide polymorphisms (SNPs) at this point in time. Such studies, even “targeted gene” studies, require larger Ns than those typically available for in-house studies by NASA. Therefore, it is suggested that SNP research, while interesting and clearly relevant, be relegated to “tech watch” status for the time being.

Encouragement of principal investigators (PIs) to attend national and international conferences would help them identify new trends, methods, and collaborations, as well as offering opportunities to present their findings to a wide audience. Authors of literature and evidence reviews funded by the HRP should be expected or even required to submit their work for publication in peer-reviewed journals. External review of these products also could provide feedback on the thoroughness of the reviews and whether the authors have considered a wide range of perspectives.

II. Comments regarding the Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (BMed Risk) Status Review

- The BMed area has considerable momentum evidenced by the range of projects in both laboratory and analog settings. In addition to literature and evidence reviews, there are a number of empirical research projects ongoing (N=13 active NRAs), five new projects will begin in 2016, and five projects have been completed. Pending NRAs on Effects of Well-Being on Performance and Biological Basis for Emotional Support increase the range of topics being addressed. With the large number of NRAs at various stages of completion, the SRP looks forward to learning which proposals are ultimately selected for funding. It is the SRP's hope and expectation that some new highly-qualified PIs/laboratories will be afforded opportunities to contribute, thus expanding the range of valid and useful perspectives/inputs from a larger pool of subject matter expertise, as recommended in the 2014 SRP review.
- The SRP notes that the long-standing Optical Computer Recognition project will run its course over the next year, and that efforts will be made to evaluate off-the-shelf facial recognition programs. However, questions arise concerning the efficacy and effectiveness of facial recognition programs in general for monitoring stress and other negative emotions on long-duration exploration missions.
- The portfolio needs a clear prioritization of efforts. The emergence of irritability, anxiety, agitation, and mood changes should be key targets for future research. Because the population of astronauts is small, an approach that incorporates personalized countermeasures/interventions may be feasible and especially effective.
- There appears to be a lack of significant collaboration with flight surgeons; input from NASA and other clinicians should be helpful in prioritizing future NRA topics. Input from those with significant experience in psychopathology, clinical psychology, or psychiatry would increase the productivity of the BMed group.
- The Dr. Davis crossover study with radiation effects might benefit from collaboration with the Armed Forces Radiobiological Research Institute (AFRRI). The study itself is very creative and Dr. Davis clearly reached out to other groups when designing the study. If the initial findings presented at the SRP meeting are confirmed, the implications regarding the potential utility of dopaminergic medications in space are considerable. The relationship between dopaminergic (and other) medications and radiation constitutes a worthwhile avenue for future research.
- Adaptive learning systems for psychology (e.g., PROMIS®, also known as Patient Reported Outcome Measurement Information System) would be relevant for dimensional approaches rather than reinventing fatigue studies.
- The literature on mindfulness is clearly relevant in terms of countermeasures. Dr. Ellen Langer is well-published in this area, but has a somewhat unique perspective. The SRP recommends that input/contributions from subject matter experts (SME) representing a broader range of perspectives be solicited.
 - In general, it is helpful if literature reviews reflect more than a single

perspective. The questions or countermeasures being addressed should be kept in mind during these reviews.

- A rigorous initial peer review by SMEs chosen by NASA should be conducted as an initial step in preparation of a condensed version of a literature or evidence review for submission to a refereed scientific journal.

III. Comments regarding the Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team (Team Risk) Status Review

- Overall, the research portfolio appears well managed and thoroughly covers a substantial range of relevant topics.
 - The job analysis was well done.
 - The Tannenbaum team debrief tool and study, for example, were both very interesting.
- The SRP has great appreciation for the research requirements (RR) process in establishing the basic questions (e.g., task switching, multiple team systems (MTS) work).
- Although work on team composition is important and necessary, training people to work together may ultimately prove most critical to mission success. Such training would focus on team members developing sensitivity to the individual differences of their team members, and how to deal with these differences. There is ambiguity about the usefulness of composition data, per se.
- Team-level balance ideas around composition are a good step.
 - Intra-individual balance (trait patterns, trait profiles) should be explored, rather than considering traits in isolation.
 - Attention to levels of variability of traits is important. Traits that do not vary in the astronaut population do not require a great deal of attention.
 - Dispositional self-awareness and self-regulation should be a focus of training and traits-related research.
- Consideration of the development of intimate relationships (e.g., romantic) within a crew is important, in terms of effects on overall team performance. Such relationships can alter power dynamics in teams.
- There is a need for greater consideration of leadership dynamics (i.e., different forms of collective leadership), dynamic delegation, and boundaries spanning within the MTS at team and MTS levels, especially in light of communication delays and increased autonomy.
- Expand the current focus on dynamic and temporal aspects of teamwork (i.e., moving between levels of interdependence). What changes as one moves between different phases of a performance episode (e.g., between the crew and mission control on the return journey)? Consideration of social network patterns may be helpful.
- The SRP recommends greater consideration of the topic of positive and negative aspects of rotating membership, especially in ground crews as part of MTSs. This issue is particularly acute in long-duration missions where there are no rotations in the flight

crew.

- The SRP appreciates the focus on the evolution of a team over the long term.
- The SRP was pleased to see the juxtaposition of topics of sleep and circadian rhythms with team connections. Social network methods might be useful for assessment of the evolution of team dynamics over time.

IV. Comments regarding the Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload (Sleep Risk) Status Review

- The SRP is favorably impressed by the progress made over the past year and the team's adoption of prior suggestions from the SRP.
 - Engagement with military researchers/laboratories to assess prior work carried out in the field of sleep/alertness medications is a highly positive step.
- The increased focus on individual countermeasures and individual differences in general is a positive development.
 - The study with Dr. Johnston and colleagues on individualized sleep-medication protocols reflects this emphasis nicely.
- Refinement and installation of the new lighting system onboard ISS is a significant success in terms of optimizing circadian adjustment and acute alertness via an environmental modification.
- "Work overload" does not deserve the prominence it is given in the Risk title. This term seems to be rather poorly defined in the present context, and while "workload" may affect sleep opportunities, it is just one of many factors that should be considered.
- Work on the stimulant side of sleep and alertness affecting medications needs to be given more attention. It seems likely that both types will be included in the onboard armamentarium during long-duration missions, with operational exigencies informing the decision of whether and when to utilize one or the other.
 - With regard to an expanded stimulant focus, the Sleep group needs to interface with BMed to consider and prepare for the potential that some stimulant medications may precipitate psychopathological effects in susceptible individuals.
- Sleep inertia and adrenergic emergency response have interplay, such that the latter may diminish the sleep inertia in a true emergency, although certain medications may downplay this response.
 - Further analysis of the scope of the problem of sleep inertia on performance following abrupt awakening is necessary to best prioritize resources before applying further effort to this issue.
- The team is encouraged to assess the relationship between sleep symptoms and other somatic symptoms (e.g., pain, allergy) as well as the potential sleep/wake effects of treating these somatic problems. Input from clinical pharmacology would be useful.
- The effects of sleep loss and/or sleep disturbance on emotional regulation deserves more attention. Sleep-loss-related emotional reactivity would likely impact teamwork, performance, and psychological health, and thus should be a focus of research, interfacing with BMed and Team areas.
- The SRP recommends de-emphasizing SNPs at this point in time. This work requires a

large N to reach useful and/or definitive conclusions, and thus currently should be left to basic researchers.

V. 2015 BHP SRP Status Review: Statement of Task for the Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders, the Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team, and the Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload

The 2015 Behavioral Health and Performance (BHP) Standing Review Panel (SRP) will participate in a Status Review that will occur via a site visit with the Human Research Program (HRP) Chief Scientist (or designee) and members of the BHP Element. The purpose of this review is for the SRP to:

1. Receive an update by the HRP Chief Scientist (or designee) on the status of NASA's current and future exploration plans and the impact these will have on the HRP.
2. Receive an update on any changes within the HRP since the 2014 SRP meeting.
3. Receive an update by the Element or Project Scientist(s) since the 2014 SRP meeting.
4. Participate in a discussion with the HRP Chief Scientist (or designee) and the Element regarding possible topics to be addressed at the next SRP meeting

The 2015 BHP SRP will produce a report/comments from this status review within 30 days of the 2015 update. These comments will be submitted to the HRP Chief Scientist and copies will be provided to the BHP Element and also made available to the other HRP Elements. The 2015 SRP Final Report will be made available on the Human Research Roadmap public website (<http://humanresearchroadmap.nasa.gov/>).

VI. 2015 BHP SRP Roster

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