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The American and Russian/Soviet space programs independently uncovered psychosocial risks inherent in long-duration space missions. Now that these two countries are working together on the International Space Station (ISS), American-Russian cultural differences pose an additional set of risk factors. These may echo cultural differences that have been observed in the general population of the two countries and in space analogue settings, but little is known about how relevant these are to the select population of space program personnel. The evidence for the existence of mission-relevant cultural differences is reviewed and includes cultural values, emotional expressivity, personal space norms, and personality characteristics. The review is focused primarily on Russia and the United States, but also includes other ISS partner countries. Cultural differences among space program personnel may have a wide range of effects. Moreover, culture-related strains may increase the probability of distress and impairment. Such factors could affect the individual and interpersonal functioning of both crewmembers and mission control personnel, whose performance is also critical for mission safety and success. Examples from the anecdotal and empirical literature are given to illustrate these points. The use of existing assessment strategies runs the risk of overlooking important early warning signs of behavioral health difficulties. By paying more attention to cultural differences and how they might be manifested, we are more likely to detect problems early while they are still mild and resolvable.

Keywords: culture, spaceflight, mental health.

"WITHOUT A DOUBT, in our country it is much easier to form a crew for a long-duration space mission than in capitalist countries. [We] are collectivists by nature."—Yuri Gagarin (20).

A generation ago, the "space race" between America and the U.S.S.R./Russia showed the world that these two very different cultures could successfully mount complex human missions to space. Each side discovered over time that psychological factors could pose a serious threat to crew well-being and, ultimately, to mission success (4,12,39). Both astronauts and cosmonauts are selected for hardiness but experience great stress. Thus it is natural that during the 30 yr of space stations, the experience of distress has not been uncommon on long-duration missions (40,72). Personal, interpersonal, and behavioral anomalies have resulted (50,51).

Now that the Russian and American space programs are partners on joint projects such as the International Space Station (ISS), they are faced with additional psychological risk factors arising from the fact that members of these two different cultures are now working together. International collaboration also offers potential benefits, such as a wider repertoire of skills and experiences among team members (122), but the present paper will focus solely on the potential mental health risk posed by having international teams. Unlike Shuttle-Mir or Apollo-Soyuz missions, ISS missions are fully international. Each crew contains at least one astronaut and one cosmonaut, and the station itself contains both Russian and American segments. Russian and American mission control centers jointly direct the operations, and Russian and American science experiments are given equal priority. Other nations have contributed station elements, crewmembers, support, and experiments as well. Historically, both the American and Russian space programs have had numerous missions with international and multicultural crews, and each side brings the benefit of this experience to bear on their current interactions.

For the sake of brevity and clarity, the focus here is primarily focused on differences between Russian and American cultures. This is the most salient cultural contrast in the ISS program because these two countries have been responsible for all human access to space stations, and because crewmembers from other countries are primarily trained within either the American or Russian program and are, thus, oriented toward one of these two dominant cultures. Moreover, there is a much more substantial literature on mission-relevant Russian-American cultural differences than on other culturally contrasting groups.

The risk factors associated with international space program teams may reflect the specific Russian-American cultural differences that have been observed in the general populations of the two countries and in space analogue settings, but little is known about whether these particular cultural differences also occur to the same extent among the select population of space program personnel. It is important to generate and test specific hypotheses based on objective data in order to avoid stereotyping and over-generalizing. As with other group-level differences such as gender differences, the variability within groups can be larger than the variability between groups. Therefore, on a particular team, contrasts in personality or other individual idiosyncrasies may produce more strain than cultural factors. Still, group-level information can be useful if it provides a meaningful increase in our ability to understand and predict important mental health and perfor-

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mance issues that could affect international teams. It is hoped that the present review will help to focus and encourage such work.

There is already evidence that Russian-American differences have actually affected joint missions (38,42,50,51). For example, members of our group and others found that during the Shuttle-Mir Program, there were systematic Russian-American differences in the style of relationships between crewmembers and mission control staff, with Russian crewmembers preferring more crew self-reliance and seeing their interpersonal environment on board the station as more supportive (50). Anecdotal evidence underscores that such differences appear to have been a source of tension and disagreement that strained the international crew's ability to mount an optimally unified, efficient response to the emergencies that occurred on the Mir (8,51). The situation on Mir was different from the ISS in terms of the high degree of cultural isolation of the American crewmembers, who were always in the minority and had relatively rare contact with their compatriots on the ground (42,43,64). The extent to which such differences reflect culture, as opposed to situation, is not known. The ISS is a better laboratory for studying the effects of culture because the two space programs are on more of an equal footing in terms of the scale of their contribution to the environment. As described above, it is a more truly international setting. In an ongoing study, our group is testing whether the Russian-American differences found during Shuttle-Mir are also found in the ISS program (40,88).

The psychology, sociology, anthropology, and business literatures have documented an array of Russian-American differences in the general population along dimensions that are potentially relevant to long-duration space station missions. While it is important to avoid over-generalizing from these, they provide an empirical basis from which to generate testable hypotheses about how they might be observed among space program personnel. What are some of these differences, and how might they affect the mental health status of crewmembers during a long-duration mission?

Potentially Mission-Relevant Russian/American Cultural Differences

Cultural values: There is a large body of research showing that there are reliable differences in values between cultures, such as between the United States and Russia (5,34,36,100). Cultural values are the shared beliefs about what is right or desirable within a society (e.g., collectivism, individualism, hierarchy, harmony). Differences in cultural values are important because they reflect individuals' motivations and predict individuals' behavior (102,104).

As noted in the introductory quote by Yuri Gagarin (20), even the first person in space recognized cultural values as relevant to long-duration spaceflight and as a potentially important difference between the two cultures' space programs in particular. Indeed, cross-national studies show that compared with Americans or to Western Europeans, Russians tend to value individualism less, and to value collectivism, power, distance, paternalism, and uncertainty avoidance more (5,74,83,116). These studies used Hofstede's classic dimensions (34) and include data collected after the Soviet era. Building on the pioneering work of Hofstede, Schwartz and colleagues have validated a structural model of cultural values across dozens of nations (101,108). In a recent study using Schwartz' country-level value dimensions and a comparison of former communist countries to Western European countries, Schwartz and Bardi found that Eastern European countries such as Russia are more embedded (collectivist), more hierarchical, less egalitarian, less mastery-oriented, and less interested in intellectual or affective autonomy (103). Another more sociological program of research on cultural values has been conducted by Inglehart and colleagues (36,37,103). Russia scores higher on being survival-oriented and lower on well-being compared with the United States and other ISS countries. Plots of multi-country data along Hofstede's, Schwartz', and Inglehart's dimensions all show that Russia is clearly discrepant from the other countries involved with the ISS, lying far from them on multidimensional plots of basic value orientations (36,81,100). As Yuri Gagarin pointed out 35 yr ago, cultural values like collectivism affect psychosocial functioning in ways relevant to space missions (20). People in cultures such as Russia who score high on collectivism tend to have a more interdependent sense of self, more context-sensitivity, a stronger focus on group-enhancing goals, and a stronger focus on avoiding negative outcomes rather than achieving positive outcomes (17,22,54,93,103,116).

Although aerospace personnel in different countries are selected using similar criteria (task aptitude, etc.), these criteria do not include basic cultural values, which typically are shared with the selectors (32). Thus, cross-national differences are likely to persist throughout a typical selection and training process (32). Studies of airline crews show substantial cross-national differences in cultural values that affect behaviors, decisions, and errors in the cockpit (32,33,68). For example, collectivism is associated with the degree to which pilots prefer a hierarchical command structure, clear rules and procedures, and reliance on automation (33). Extremes on these dimensions, such as uncritical reliance on procedures, can reduce safety, as can the miscommunication and role confusion engendered by differences along these dimensions between members of international crews (32,33).

Differences in cultural values may be behind the operational and group climate differences that have been observed between Russian and American space programs (50). For example, the training for space station crews tends to be more didactic in Russia and more hands-on in the United States (52). Moreover, our group found Russian-American differences in leader support, task orientation, work pressure, and managerial control among Shuttle-Mir personnel (43). A more systematic investigation into the extent of value differences among space program personnel could clarify the reasons behind stylistic differences, help predict potentially troublesome issues, and work to prevent misunderstandings and tension on international teams.

Subjective well-being: Subjective well-being refers here to perceived mental health and also its opposite, mental distress. The international scientific literature on general population samples has shown repeatedly using various techniques that distress levels tend to be elevated among Russians, but it is unknown if this is relevant to the select sub-population of space program personnel (28,31,82,91,106,107). Inglehart's group found that Russians experienced a dramatic drop in their already-low levels of subjective well-being between 1981 and 1990, and again between 1990 and 1995 (36). Countries that score higher on collectivism, are formerly communist, and have a lower per capita income also tend to score lower on measures of subjective well-being (10,16,37). Because economic, political, and social changes have been taking place rapidly in recent years in Russia, these associations may be less relevant now, and their relevance to space program personnel is as yet unknown. Furthermore, any apparent difference may be caused by the fact that Russians and Americans may react somewhat differently to psychological assessment methods (86,89).

Emotional expressivity: Emotional expressivity norms vary greatly across cultures, and on average Russians are relatively more expressive than Americans and people from other Western countries (47). When the Minnesota Multiphasic Personality Inventory was re-normed for the Russian population, the threshold for clinical significance had to be raised on the depression scale because Russians were more willing to report depressive experiences (89). Research shows that in contrast to Americans, Russians tend not to feel the need to suppress negative emotions or to display exaggerated or fabricated positive emotions during routine interactions such as at the workplace (66,123). In two multi-country comparison studies, Russians were the most extreme in their willingness to display negative emotions such as hostility and dysphoria (13,66). These differences were found when interacting with colleagues but not with strangers (66). Russians also were the most extreme at displaying positive emotions such as joy and happiness (13,66). These differences in emotional display norms may affect the work of international teams and are well known to the international expatriate business community in Russia (11,70,113,115,126). Although this appears to be a relatively pervasive and enduring aspect of Russian culture, recent changes in the Russian business culture may be attenuating this difference, and its relevance for space crews has not been formally documented.

For space program personnel, the impact of differing emotional expression norms is likely to be complex. For example, cosmonauts may display greater expressivity in their personal relationships but may be more reluctant than astronauts to report negative emotional states to outsiders (50). In general, in addition to the strains associated with two historically rival organizations learning to work together, it seems likely that that strains associated with differences in emotional expression norms have affected the working relationships between members of the Russian and American space programs. Such strains potentially could have affected the morale and behavior of the individuals and groups involved.

Privacy and personal space norms: Privacy and personal space norms are also likely to differ between American and Russian space program personnel. Such differences have clear implications for long-duration missions in isolated and confined environments because they can trigger conflict in multicultural groups (2,46,63). There is not even a word for "privacy" in Russian, and little concept of it (14,85). The closest Russian terms back-translate into English as aloneness, seclusion, solitude, keeping secret, and loneliness. Americans living in Russia commonly remark on what they perceive as the intrusiveness of their Russian colleagues, such as telephoning with work-related questions late at night. When Americans express a wish for private time, Russians may interpret this as indicating that the American is unwell, unfriendly, or offended. Such differences in privacy norms could become difficult on a small space station (46,112). Again, it has not been established whether these differences exist among actual ISS crewmembers.

Personal space norms are also likely to be quite different (63). Russians tend to be more accustomed than Americans to living in small spaces, having minimal personal belongings, and living and working in close physical proximity to others (14,85). In part, this is a direct legacy of Soviet-era regulations [e.g., government-issued apartments allotted less than 11 square yards of living space per person nationwide (14)]. Living space norms may be changing as it becomes more common to live in houses outside of the city rather than in urban apartments, but this is still rare and would mainly affect the psychology of the cohort of Russians who are currently children. In a recent study, I noted that Russians still tend to live in small spaces: the average person in a sample of Russian adults lived in a three-person household in a one-bedroom apartment [n = 180; mean household = 3.1 persons (SD = 1.2), mean rooms = 2.4 (SD 0.9)] (87). Although this was an urban, psychiatric sample, it was demographically very similar to the general population (23–25, 87). Even in small towns and villages, it is normative throughout Russia and the former U.S.S.R. to live in apartments or houses that would be considered small or crowded by American standards. The finding of an average of about one person per room in Russia is in contrast to the national American norm of less than 0.5 persons per room (121). Even in Manhattan, where living spaces are small, about 90% of households are spacious enough to have fewer than one person per room (120). The same is true for Houston, where many space program personnel live (119). This suggests that, on average, Russian crewmembers might be expected to adapt more readily to living in close proximity to others in the relatively small volume of a space station.

Compounding the issue of personal space and privacy are differences in personal hygiene norms. Americans tend to bathe more frequently than many other cultural groups, including Russians. This difference is reflected in the hygiene products and procedures considered standard in each space program, with the

Americans using more water for this purpose (52). International surveys and anecdotal reports stress that differences in hygiene norms can be a source of annoyance and interpersonal tension among space crews (52,64,98).

Personality: Another potentially mission-relevant difference has to do with the prevalence of personality types. A fundamental five-factor structure of personality has proven to be remarkably invariant across cultures (67) and has been validated in Russia (80). This means that the basic structure of personality has cross-cultural validity. Although the dimensions appear to be universal, the average scores on them vary across cultures (7). Compared with other nations, Americans tend to score especially high on Extraversion and Openness, which are likely to be low among Russians (29,59,65,117).

Astronauts are selected to be a homogeneous group along a variety of personality dimensions, but they have been shown to vary on some dimensions to the same degree as people in the general population, and they may, therefore, be expected to reflect their national culture in these respects (71). These dimensions include Extraversion, Openness, and Expressivity (71). Extraversion has been related to subjective well-being in the general population (99). Openness has been related to performance in cross-cultural settings (61). Extraversion and Openness are likely to be consequential for international space missions because they have been related to performance during isolated and confined missions in Antarctica, in space station simulators, and in terms of astronaut peer ratings (71,78,92). Expressivity has been related to coping and mission success (95,96) and is, therefore, of potential relevance to this population. Our group's prior research on personnel involved in the Shuttle-Mir Program found that Russians seemed to be more reactive than Americans: when reporting a critical incident, Russian participants rated the impact of the incident on themselves and their group to be stronger than the ratings given by Americans, although this difference could not be confirmed statistically given the small samples (43). If confirmed, this finding may be related to cultural differences in Expressivity. In general, it is likely that the combination of personalities in a crew will affect its style of functioning. If certain personality types are more common in Russians vs. Americans, this should be taken into account in composing compatible teams.

Foreign language competence: Foreign language competence is likely to be stronger, on average, among Russians than Americans. Americans are notorious among other developed nations for having especially low rates of foreign language competence, knowledge, and curiosity about other countries (6,73,84). Two prior studies show that Russian space program personnel tend to be more flexible than their American counterparts regarding working in bilingual teams (42,46). A discrepancy in foreign language skills reportedly was one of the factors that provoked a fistfight between crewmembers on a recent space station simulation (51). Although this study did not include American crewmembers, the incident demonstrates the importance of language skills and multicultural competence to crew well-being on international missions. Our group is currently collecting data on the culture and language background of ISS crewmembers and mission control staff in both countries, which should provide initial normative data for this population.

Gender norms: Adherence to traditional gender roles varies across cultures and tends to be stronger among Russians than among Americans (60). Such differences have been a source of strain on international teams in analogue environments and space missions (56,57,64). A recent study conducted in a space station simulator found that having a mixed-gender crew made a dramatic adverse impact on the level of tension and cohesion and on the success of the mission (27,94). However, another similar study found the opposite effect (97). Part of the difference in these findings is related to culture. During the study that included Russians and Westerners (Europeans and a Canadian), the discrepancy between gender norms among the Russians vs. the non-Russians seemed to be a major source of friction, over and above any strain caused by gender differences per se (94). In other words, a group may be able to accommodate gender differences if group members all have compatible understandings of what these differences are. Our group's ongoing ISS study is collecting data on both genders, and promises to yield important findings on the relation of gender with well-being and group dynamics on ISS crews. For example, mixed gender crews could have a wider repertoire of leadership styles available. Across many national cultures, the two genders are socialized differently such that women tend to be more skilled at relationship-enhancing functions and men tend to be more skilled in instrumental functions, both of which are important leadership roles that can affect the cohesion of the group over time (18,41,58). These issues should be taken into account when composing crews.

Personal relationships with co-workers: One of the lessons learned from the Shuttle-Mir Program was that personal relationships are crucial for reaching agreements and conducting ordinary work activities in international Russian-American teams (8,50). Americans tend to be more accustomed to adhering to well-defined job roles, such that a new person in the job would be expected to interface with their Russian counterpart similarly and without much of a transition. Therefore, in the absence of cultural training, Americans tend to underestimate the importance of personal relationships to conducting productive work with Russian co-workers (15,115). Since international crews are trained together intensively over a lengthy period, it may be easier for crewmembers to establish these relationships than for mission control personnel, who may have less of an opportunity to develop them. This is one example of how cultural differences are likely to pose more of a strain on the working relationships of ground control members than crewmembers (35).

Cultural heterogeneity in general: Although this review is intended to focus primarily on Russian-American national differences, it is important to note that many other cultural differences could affect missions. Kring

(52) provides a thorough review of the mission-relevant dimensions along which cultures may vary. Several surveys have highlighted the wide range of cultural issues that are likely to affect international space crews regardless of the particular nationalities involved (64,98). Some researchers posit that cultural contrasts can become magnified during missions (51).

Heterogeneity of any type could pose a risk to crew communication, cohesion, and functioning (12). For example, the inclusion of scientists and others as payload specialists strained the astronaut group culture formerly composed mainly of pilots (76). Subgrouping along professional lines is common in space analogue environments such as Antarctica and is likely to be a factor affecting group dynamics in space as crew size increases. The formation of cliques has been associated with distress (79). Issues that arise between crewmembers may not affect the entire crew equally (124). Evidence from space and analogue environments also shows that each crew develops its own group culture and that the nature of that culture takes longer to cohere and is more difficult to predict when crews are more heterogeneous (76,122). Heterogeneity adds to the amount of information that crewmembers and mission control personnel must process in order to accurately understand the goals, intentions, and situational constraints associated with their communications, thereby increasing the cognitive load required (9).

Furthermore, cultural differences may interact with each other. For example, there may be within-country differences between ethnic groups, and at the same time there may be between-country differences in the degree and type of prejudices held toward minority groups. Similarly, there may be differences between genders as well as differences between nations in the degree and type of gender differences that are normative within that culture. Personality may vary by nationality and by occupational group (110). Cultural differences may be more pronounced between mission control personnel than between crewmembers (35). In short, there are many aspects of culture that could affect a mission, and the Russian-American distinction is only one example.

Effects of Cultural Differences on Mental Health During Missions

After exploring the cultural differences that may affect mental health on the ISS program, the next step is to consider how such differences might play out. It is important to consider both how cultural issues may affect the likelihood of distress and how they may affect the accuracy of detecting distress.

Cultural differences could affect the likelihood of distress occurring in a crewmember. If the base rate of distress is higher in the general population of one culture, then the prevalence of distress may be commensurately higher among crewmembers from that culture, unless the difference does not survive the crew selection process. Cultural differences could also affect the likelihood of distress by serving as a source of stress or strain on international crews caused, for example, by misunderstandings, more effortful relationships, or a sense of cultural isolation. If culture affects the likelihood of distress, this would be observed as differences by culture in the frequency of distress or in the intensity of distress, as indicated by mental health assessment methods, such as questionnaires and interviews. However, it is impossible to interpret such differences without first establishing that the methods work in an equivalent fashion in both cultures. My research suggests that psychological assessment tools do not always function equivalently in Russia and the United States (86,89).

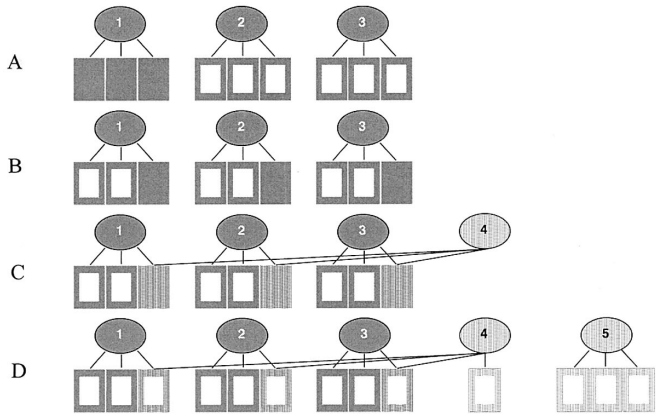

Fig. 1. Effect of cultural differences on case identification. One culture is denoted as dark gray and another culture as light gray. Symptoms are shown as boxes and disorders as ovals. All represent forms of distress that could jeopardize mission safety. In case (A), the patient has all three symptoms of Disorder 1 and would be diagnosed. In case (B), the patient also has three symptoms, representing an equivalent amount of distress, but would not be diagnosed by a doctor from the dark gray culture. However, case (C) shows that these three symptoms would meet criteria for Disorder 4, which is recognized only by the light gray culture. Using diagnostic criteria from both cultures would result in increased case identification. This is especially true if additional symptoms from the light gray culture's diagnostic system were also included in the assessment. Case (D) shows that such an expanded assessment would allow for a more thorough, culturally appropriate evaluation of Disorder 4 and also would allow detection of Disorder 5. Assessment tools based only on the dark gray culture's diagnostic system would result in under-diagnosis and under-detection of important forms of distress.

Cultural differences may affect the accuracy of methods for detecting distress so that methods will not work equivalently. Early, accurate detection of even mild syndromes is important in long-duration space missions because of the extraordinarily high level of sustained performance required for safety and mission success. Regardless of whether there are differences by culture in the frequency or intensity of distress, there may be differences between cultures in the way that symptoms cluster together (90). If indicators are patterned differently, this may impede the early detection of problems. Assessment methods that assume one type of pattern may be inaccurate at detecting another type.

Cultural differences in clustering of symptoms can impede case identification, as seen in the following schematic example (**Fig. 1**). If a patient has all 3 of the symptoms that are indicators of Disorder 1 (dark gray boxes in Fig. 1A), and none of the symptoms connected with Disorder 2 or 3, this is clearly a case of Disorder 1. A doctor from the dark gray culture would make this diagnosis using a test corresponding to the dark gray culture's model of illness. If a person has one symptom from each disorder, as shown by the three dark gray

TABLE I. REGRESSION MODELS PREDICTING POMS DEPRESSION: SHUTTLE-MIR AND HUBES DATA.

	Russian			American	
Variable Predicting Depression	Mir Simulator (HUBES) (N = 3)	Ground Personnel (N = 16)	Cosmonauts on Mir (N = 8)	Ground Personnel (N = 42)	Astronauts on Mir (N = 5)
Fatigue	0.12*	0.19*	−0.08*	0.07	−0.04
Anxiety	0.09	0.08	0.07	0.27*	0.51*
Anger	0.04	0.53*	0.37*	0.23*	0.09
Vigor	−0.001	−0.03*	−0.01	−0.02*	0.01
Confusion	0.19	0.29*	−0.09	0.12	0.68*

*$p < 0.05$.
Note: Table adapted from Ritsher, Kanas, Salnitskiy (88). Each column represents one model. Beta weights are shown for fixed-effect terms. Each model was controlled for repeated-measure subject effect (not shown). Items with zero mean and SD among all cosmonauts or all astronauts were not included in calculating POMS scores.

boxes in Fig. 1B, the patient would not meet criteria for any disorder and would not be identified as in need of clinical attention, even though he or she is suffering from the same number of symptoms. Suppose, however, that the patient is from the light gray culture and that these three symptoms are cardinal symptoms of another disorder in that culture, but this was not reflected in the assessment tool used by the evaluating doctor (Fig. 1C shows these three symptoms connected to a light gray disorder). Thus, a cultural bias has led to a false negative—the erroneous judgment that there was no disorder present. Doctors aware of both sets of models (the dark gray and the light gray) could use both algorithms to identify cases from this overall set of symptoms. However, there could be additional symptoms or disorders that are common in the light gray culture which are not included in the standard assessment tool that contains only the dark gray symptoms (Fig. 1D shows an additional light gray disorder with associated symptoms). Thus, both the range of symptoms and their patterning needs to be taken into account for all cultures in which the tool will be used.

The ethnopsychiatric and epidemiologic literatures are replete with examples of cultural differences in the patterning of mental health syndromes (e.g., 19,21,26,48,118). This is a real-world problem, and we have some evidence that it may be relevant to Russian and American crewmembers and mission control personnel during long-duration space station missions. Even aside from the issue of whether there actually are differences in the way that distress is experienced or expressed, there are definitely differences in the Russian and American models of distress that are used in mental health evaluations. These differences pertain to the historical separation of the Russian and American space programs and of Russian and American psychiatry.

A space-related example comes to mind. There is a syndrome that Russian cosmonauts are monitored for, psychological asthenization (psikhicheskaya astenizatsiya), which is considered a mild, reversible form of neurasthenia. It is not considered a form of psychopathology, but it is at one end of that spectrum. In addition to mood states such as depression and irritability, neurasthenia-spectrum disorders include a range of psychosomatic features such as fatigue, weakness, pain, headaches, sleep disturbances, and heightened sensitivity to stimuli (3,44,49,72). Neurasthenia-spectrum syndromes are thought to result from prolonged mental strain, such as that which might occur during a space mission or other types of prolonged mental activity (55,72,105). In Russia, psychological asthenia and neurasthenia are considered to be a common form of distress, both by clinicians and by laypersons (62). Neurasthenia is seen as a bona fide mental disorder in the Russian and European psychiatric classification systems, but not in the American system, where it does not appear in the American Diagnostic and Statistical Manual, 4th Edition (DSM-IV) (1,44,69,125). Similarly, there is debate in Russia about whether American models are accurate for the Russian population (114).

According to the American conception of psychological distress, depression frequently is linked with anxiety. A recent factor analysis of data from a major epidemiologic investigation in the general population confirmed that depression and anxiety form a single joint construct among Americans (45,53). Fatigue may occur as a secondary feature in the context of depression, but syndromes where fatigue is prominent are typically diagnosed as chronic fatigue syndrome or a somatoform disorder (109).

Accordingly, we sought to test these differences in the patterning of distress indicators. In a recent analysis of mood state data collected during Shuttle-Mir missions and a Mir simulator study (45), we found some evidence for Russian-American differences in the patterning of indicators on the Profile of Mood States (88). **Table I** shows the results of mixed-model linear regression analyses controlling for the varying number of responses per person. We found that, as predicted, fatigue is associated with depression in the three Russian samples but not in the two American ones. This association is in the positive direction for the Russian Human Behavior in Extended Spaceflight (HUBES) study crewmembers and the Shuttle-Mir ground personnel. For cosmonauts in space, the association is negative. However, for these same cosmonauts on the ground during the baseline data collection periods (not shown on the table), it was positive ($t = 3.18$, $p < 0.005$, pooled preflight and postflight data). Also as predicted, anxiety is associated with depression in both American samples but not any of the three Russian ones. We had also predicted that anger/irritability would be more strongly related to depression among Russians. For the

Shuttle-Mir samples, this was true for the crew and to a lesser extent for the mission control personnel. This finding did not replicate for the HUBES sample. We did not have hypotheses about how vigor or confusion would relate to depression differentially by culture. A study of ISS personnel using the same measures is currently underway and will allow for replication of these analyses. For the purposes of the present paper, these data are presented to illustrate how cultural factors may affect the way distress is manifested.

Recommendations

Basic research: Further research is needed to establish the extent to which these potentially mission-relevant cultural differences, which have been found in the general population, are actually present among the select population of space program personnel. This work should focus on all ISS partner countries. Such findings can be used to generate specific, empirically based hypotheses about the effects of cultural differences on behavioral health during long-duration international missions. Furthermore, they could be used as norms against which to compare the characteristics of future ISS crews or related international work groups on the ground.

Cross-cultural psychometric validation and integration of assessment methods: The use of existing (separate Russian and American) mental health assessment strategies runs the risk of overlooking important early warning signs of behavioral health difficulties. By paying more attention to cultural differences, we are more likely to detect problems early while they are still mild and resolvable and do not reach major pathological proportions. Existing assessment methods should be psychometrically validated for each of the cultural groups with whom they will be used. Moreover, the methods should be integrated and expanded so that the full array of culturally relevant symptoms and syndromes may be assessed in a uniform and systematic manner. Mental health personnel supporting an international mission should be cross-trained accordingly. For example, American doctors should be trained to recognize the early signs of psychological asthenization. As part of the Multilateral Medical Operations Panel, the Spaceflight Human Behavior and Performance Work Group has already begun integrating the training, evaluation, and intervention strategies used by ISS partner countries.

Crew selection: Cultural competence should be assessed when selecting individuals for international missions, and cross-cultural compatibility should be assessed when composing specific crews (30). For example, having a commander who is a woman or younger than the other crewmembers may pose a potential difficulty with some combinations of cultures but not others. A crewmember who has a low level of skills at noticing and reading the non-verbal behavior of people from another culture may not pose as much of a risk to the crew if that crewmember has a compatriot on board who is highly skilled in that area.

Training: Up-to-date information about mission-relevant cultural differences should be taught to crewmembers and others working on ISS missions. This type of training should include team-building exercises and other experiential components in addition to lectures. In addition to promoting interdependence and bonding, these activities would help crewmembers from different cultures learn to read one another more accurately. Although the cultural content could be bolstered and made more consistent across agencies, such training techniques are already in use. The Russian, American, and European space programs all offer team building and group activities as part of pre-selection training. Mental health staff in the Russian space program continuously evaluate crewmembers during the course of their routine training and socialization activities and monitor for incompatibilities, and these evaluations have led to changes in crew composition even after the crews have been selected (77).

As part of their post-selection training, crews should also be encouraged to systematically identify ways that cultural differences and other types of heterogeneity (e.g., gender, age) may affect their particular group, and they should be led through a process aimed at developing consensus about strategies for dealing with them (52,75). Since crewmembers are often reluctant to air their interpersonal difficulties to outsiders, a crewmember could be trained and assigned to support the crew's psychological health during flight, just as a crewmember is designated as the medical officer (50,75). This crewmember should be trained to recognize the influence of culture on individual and group functioning. This could be a rotating position and would ideally be outside of the main chain of command (111). Family members may be able to provide more helpful support to one another and to their crewmember family member if they have cultural training as well. It is also likely that this type of information and procedure would be helpful for mission support personnel who will be working together—not just cultural training for people who will be stationed overseas, but for any administrative or operations staff who will have ongoing working relationships with their international counterparts.

Conclusion

Cultural-psychological factors are especially important now for mission success because of the International Space Station program. Although a great deal has been learned about how to work together, fundamental differences persist and cause strain. Furthermore, the effects of this strain may not be accurately detected early if there is cultural bias in the assessment methodology. The potential for culture-related risks to mental health will only be compounded as there is more participation from other international partners. These factors will become even more important as we prepare for much longer exploration-class missions to Mars and beyond. Improved prediction, prevention, and treatment of distress will improve the safety of international long-duration space missions.

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