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Coping in the final frontier: An intervention to reduce spaceflight-induced stress[1]

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Abstract

Research in human spaceflight has extensively documented how microgravity environments, such as spaceflight across Low Earth Orbit (LEO), affects astronauts' and Spaceflight Participants' emotions. However, a more refined understanding of this topic will become especially relevant as national and international space agencies increase the duration of manned space missions, and as the private sector fully enters the aerospace arena. In this paper, we analyze the strengths and weaknesses of the four main types of interventions for dealing with the stressors associated with human spaceflight (i.e., ergonomic, physiological, psychological, and psychosocial), and then elaborate on a psychosocial intervention

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grounded on evidence-based interventions across several fields of psychological research. Among the components of such interventions, we recommend adopting advanced stress coping strategies, developing emotional and intercultural competencies and crafting a shared social identity among crew members. Our proposed intervention aims to enhance the efficacy of social support as a key coping mechanism and applies to crewmembers and spaceflight participants of diverse cultural backgrounds who, most likely, will work using computer-mediated communication (CMC).

Keywords: spaceflight induced stress; proactive stress coping; Emotional competencies; positive emotional contagion; Social identity; Social support

Lidando com o stresse na fronteira final: uma intervenção para reduzir o stresse induzido por voos espaciais

Resumo

Investigações em voos espaciais tripulados documentaram extensivamente como os ambientes de microgravidade, como voos espaciais pela órbita baixa da Terra (OBT), afetam as emoções dos astronautas e dos participantes do Voo Espacial. No entanto, um entendimento mais refinado deste tópico tornar-se-á especialmente relevante, à medida que as agências espaciais nacionais e internacionais aumentem a duração das missões espaciais tripuladas e que o setor privado entre totalmente na arena aeroespacial. Neste artigo, analisamos os pontos fortes e fracos dos quatro principais tipos de intervenções para lidar com os stressores associados ao voo espacial humano (ergonómico, fisiológico, psicológico e psicossocial) e depois desenhamos uma intervenção psicossocial sustentada em intervenções baseadas em evidências realizadas em vários campos da investigação psicológica. Entre os componentes de tais intervenções, recomendamos a adoção de estratégias avançadas para lidar com o stresse, o desenvolvimento de competências emocionais e interculturais e a criação de uma identidade social partilhada entre os membros da tripulação. A nossa proposta de intervenção visa aumentar a eficácia do apoio social como um mecanismo chave para lidar com o stresse e aplica-se a tripulantes e participantes de voos espaciais de diversas origens culturais que, muito provavelmente, irão trabalhar usando comunicação mediada por computador (CMC).

Palavras-chave: Estresse induzido por vôos espaciais; enfrentamento pró-ativo do estresse; competências emocionais; contágio emocional positivo; identidade social; apoio social

INTRODUCTION

Long-term human spaceflight, understood as manned spaceflight outside Earth's orbit (Low-Earth orbit, or LEO) seems like a distant dream, but recent policy changes within the aerospace sector are transforming such vision into a plausible reality. For example, space agencies now outsource LEO activities such as resupplying the International Space Station (ISS) to private companies such as SpaceX. In turn, such cooperation provided new insights on how to tackle the current roadblocks that prevent long-term human spaceflight (e.g., propulsion, communications, habitat design, etc.). However, despite "technical" advances, experts agree that there are still challenges in the "human" front. Such challenges set the stage for organizational behaviorists to contribute to the advancement of manned spaceflight.

Human Spaceflight is an inherently risky activity that can induce intense distress, even in the most seasoned astronauts (Bensoussan, 2010). Surprisingly, although spaceflight-induced stress (SIS) is one of the four biggest obstacles against sustained long-term human spaceflight (Clément, 2005), prior scholarly work has neglected exploring psychosocial interventions to cope with SIS. Such neglect is surprising, as mainstream stress research shows that social support is a major mitigating factor (Frisch, Häusser, van Dick, & Mojzisch, 2014). One reason for such absence might be that there are just too few actual astronauts, or that national space agencies do not make SIS-related data available to the general public. However, this may change as the private sector enters the human spaceflight arena.

Prior research shows that intensive training gives professional astronauts the self-confidence to cope with spaceflight-induced stress, regardless the adverse effect that microgravity has on the human psyche (Geuna, Brunelli, & Perino, 1995). For example, even a short to moderate exposure to microgravity can induce exhaustion and asthenia, euphoria, depression, accentuation of negative personality traits and cognitive effects, such as reduced fine manual control and psychomotor performance (Morphew, 2001; Urbina & Charles, 2014). However, we still lack a clear understanding of how microgravity affects psychosocial phenomena, such as group-level processes (e.g., psychological safety, trust, intra-group conflict), social cognition (e.g., shared mental models, social identity), and social status (e.g., leadership). Further, there is even less information about how a combination of microgravity and the unavoidable isolation that a long-term spaceflight mission implies may have on the psychosocial aspects of spaceflight-induced stress. Considering the gaps within the existing academic literature on spaceflight-induced stress, and particularly those regarding its psychosocial antecedents and consequences, the goal of this work is to explore SIS stress from an organizational behavior lens and propose an intervention to prevent its negative outcomes.

Sources of spaceflight-induced stress

In a human spaceflight environment, stressors may be of physical, physiological, psychological and psychosocial nature. The physical stressors category collects all those elements inherent to a spaceflight environment that create either physical or psychic strain (e.g., noise, radiation, microgravity, and so forth). Physiological stressors reflect the impact of physical stressors on SFP bodies (e.g., the absence of time parameters, space adaptation sickness; Assad & de Weck, 2015; Kluge et al., 2013; McKenna-Lawlor et al., 2015). Instead, whereas psychological stressors mainly affect the individual consciousness of each astronaut (e.g., isolation, monotony, confinement, high levels of mission complexity, high-risk conditions), psychosocial stressors influence astronauts' and SFPs' ability to function effectively as a team. Whereas physiological and psychological stressors have been extensively studied, research on how a spaceflight environment, and how microgravity may influence such psychosocial stressors is scarce at best. We cover physical, physiological, and psychological stressor in more detail in the next section.

In Earth, psychosocial stressors may derive from the contextual features of the environment in which teams operate (e.g., high-stakes context; Cohen et al., 2016), team characteristics, such as differences in crewmember (age, sex, tenure or cultural background), job characteristics (e.g., monotony, reduced autonomy). For example, a high-stakes context (i.e., a work environment in which errors may result in loss of life) imposes high team coordination demands, and thus increases team-members stress (Sandal, 2001). Moreover, astronauts' anecdotal accounts suggest that microgravity is a critical, unexplored factor that will most likely strengthen the adverse effects of these psychosocial stressors on team processes and outcomes. Hence, making psychosocial trade-offs is necessary if we are to reduce SIS (dis) stressors to their minimum expression.

In what refers to team characteristics, one typical trade-off involves team diversity. On the one hand, people of similar cultural backgrounds, corresponding values are likely to interact more fluidly with each other (Vandenberghe, 1999), but may exhibit a major risk of groupthink (Janis, 1982). On the other hand, whereas gender and cultural diversity may be highly beneficial for teamwork, it may also be counterproductive in high-stakes environments. Whereas team diversity increases the richness of information comprised in teams' shared mental models, understood as a collective understanding of critical information that teams use to operate on their collective tasks, if team members differ substantially in their cultural norms related to work ethics social conflict, and, hence, distress may arise.

We understand *culture* as a set of observed attitudes, values, beliefs, and norms shared through generations and guiding individual behaviors (De La Torre et al., 2012; Schein, 1984). Some studies show that a shared understanding and respect about the underlying assumptions, values, and practices is an essential trust-developing factor among team members (Glazer, 2008); in reality, is often tough to achieve such shared understanding (Triandis, 1994). There fore, a lack of shared understanding may lead to unnecessary conflicts. For example, a higher richness of information is not just beneficial per-se and could jeopardize teams' effectiveness if their members do not invest sufficient time to decode the idiosyncrasies in each other's communicational styles (Nurmi, 2011). For example, whereas team members from a *high-context* culture may prefer an indirect approach to conflict management, team members from a *low-context* culture are more likely to adopt a direct and structured approach to conflict management (Adair, Okumura, & Brett, 2001; Yum, 1988). Hence, in a conflicting event the first group will seek to resolve a conflict by avoiding confrontation, the second group will see this as a sign of weakness.

Team diversity may also lead to intercultural communication problems, which not only apply to face-to-face communication, but to computer-mediated communication (CMC) as well (Lira, Ripoll, Latorre-Navarro, & Monzani, 2016; Monzani, Ripoll, Peiró, & Van Dick, 2014). For example, in LEO missions, CMC occurs between the members of the spacecraft and the Earth ground control(s), geographically distributed in the form of Global Virtual Teams (GVTs; Glazer, Kozusznik, & Shargo, 2012). Cultural differences were particularly relevant for GVTs due to limited non-verbal cues to convey meaning that may cause ambiguity, miscommunications, and other disparities that may affect every stage of the stress process. In the highly stressful situations that may occur during spaceflight, to achieve effective communication involving SFPs from different cultures, it is crucial to invest greater effort in communicating. For example, communicating effectively involves using verbal and nonverbal cues to transmit to peers when they transgress one's cultural values and norms (e.g., individualism, hierarchy, and polychronicity; this last refers to the extent to which people in a culture prefer to be engaged in two or more tasks or events simultaneously). GVT research shows that communicating concisely (i.e., in a way that everyone comprehends), at regular intervals, and using the adequate media reduces culturally-induced stress (Adair et al., 2001; Alexander, 2000; Molinsky, Krabbenhoff, Ambady, & Choi, 2005).

Examples of astronauts' adverse reactions to culturally-induced stress are the Isolation Study for European Manned Space Infrastructures (ISEMSI) or the Simulation of Flight of International Crew on Space Station (SFINCSS-99). In the ISEMSI, negative reactions not only had individual psychological consequences for astronauts but led to deviant behaviors, which not only increased intra-group and inter-group conflict but truly jeopardized these simulations' success. Further, a detailed analysis of Skylab-4's New Year mutiny suggests that microgravity-induced mood changes might increase culturally-induced stress. In short, after 84 days in space and some disagreements with Earth control, the crew of the Skylab-4 mission announced an unscheduled vacation day, turned off the radio and relaxed, something unheard of in prior spaceflight missions (Clément, 2005). The Skylab-4's mutiny exemplifies well how isolation and microgravity can increase intergroup conflict, which is commonly known as the "Us vs. Them" syndrome (Tajfel & Turner, 1979). Social identity theory suggests that all human beings shape their identity both on a personal level (i.e., highlighting one's individual strengths and weaknesses) but also on a social level (i.e., emphasizing the characteristics of the groups one belongs). Because the positive features of one's group feedback onto a person's self-esteem, people often try to cast the groups to which they belong in a more positive light as compared to other groups. This behavior can sometimes lead to prejudice, discrimination, and conflicts between groups (van Knippenberg, 2003). Without training on psychosocial dynamics that can complement training on emotional self-regulation, the Skylab-4 crew members were ill-equipped to cope with the psychosocial demands of long-term spaceflight, and hence the "Us vs. Them" syndrome had such a substantial impact on their behaviors. Thus, we propose that additional training grounded on social identity research (Haslam, Eggins, & Reynolds, 2003) might have prevented such an intense inter-group conflict between the Skylab's crew and Earth control team.

Existing interventions for managing spaceflight-induced stress

SIS researchers usually rely on either a horizontal bed rest (HBR) or head down tilt bed rest (HDT) approach to study spaceflight-induced stress. HBR and HDT can efficiently simulate the conditions of microgravity and spaceflight on Earth (e.g., of reduced mobility and isolation). In most cases, during and shortly after a period of either HBR or HDT, an increase in depression and neurotic symptoms follow (Ishizaki et al., 2002), reducing individual performance. However, such effects did not occur for HBR participants who could socialize (Dolenc, Tušak, Dimec, & Pišot, 2008). Similarly, existing SIS interventions approach the reduction of microgravity's adverse effects on moods and emotions in four ways (ergonomic, physiological, psychological and psychosocial). While all these routes have strengths and weakness, any attempt to reduce SIS during long-term spaceflight missions will require integrating all four routes into an overall solution.

The ergonomic approach involves factoring stressors into spacecraft habitation design (Peldszus, Dalke, Pretlove, & Welch, 2014). For example, Burattini, Bisegna, Gugliermetti and Marchetti (2014) suggested a habitation module design countermeasure, which aims to reduce isolation and confinement, and thus their adverse effect on the mood of SFP. Their design challenges the classic idea of habitation systems as a life-support system, moving towards the notion that human factors are a significant element in the overall spacecraft design process (Messerschmid & Renk, 2010). However, we know that neuroticism (or low emotional stability) moderates the level in which the environment affects mood and that, over time, neurotic people tend to filter out environmental stimuli (Jang & Namkung, 2009). Thus, as microgravity strengthens neuroticism's effect on emotions, the attenuating effect of habitation design on SIS should decay faster in a long-term human spaceflight environment.

Physiological SIS interventions involve artificially restoring SFPs' hormonal balance to strengthen their emotional regulation. For example, Gouvier et al. (2004) combined hormones that increase cognitive activity such as alendronate or testosterone, to regulate emotional alterations during microgravity. To simulate the physiological effects of microgravity, they used a -5% HDT combined with triiodothyronine (T3). T3 is a hormone that accelerates bone metabolism during bed rest (Smith et al., 2008), reporting that participants in conditions which either combined T3 and alendronate or testosterone, reported lower stress levels and higher performance respectively than the control group. Although physiological SIS interventions deliver positive results, there are some caveats. For example, in long-term missions such as a two-year mission to Mars, there may be potential medical issues with the side effects of continuous hormonal dosage, as Wood (2008) reported drug dependence effects for anabolic–androgenic steroids (AAS), such as T3. In consequence, a SIS intervention for long-term manned missions should ideally be *non-invasive* at the physiological level, to protect SFPs from potential dependency to AAS such as T3.

Psychological SIS interventions involve intensive mission-specific training. Before any LEO mission, professional astronauts conduct numerous exercises to reduce the number of possible unforeseen contingencies, enhancing their ability to remain calm in highly stressful but *known* situations. However, anticipating all possible contingencies for the complex, unknown context of a long-term spaceflight mission seems impractical, if not impossible. Hence, reducing SIS requires a more direct approach involving the development of four core human emotional competencies, so that astronauts and especially SFPs can regulate their emotions in *unknown* situations. A valid alternative would then be to develop SFP's emotional intelligence (EI). Emotional intelligence refers to the ability to understand adequately and manage emotions (Mayer, Roberts, & Barsade, 2008) through four core emotional competencies. More precisely, emotional competencies imply the capacity to (1) perceive, (2) assimilate, (3) understand, and (4) manage emotions in oneself and others. The first, emotional perception, refers to deciphering social information and recognizing emotional expression. Instead, whereas emotional assimilation involves knowing how to include and exclude emotions from cognitive processes, emotional understanding implies a conscious reasoning about emotions. Moreover, emotional understanding enables to use one's knowledge about emotions to understand how different emotions are related, perceive the causes and consequences of feelings, label and categorize feelings, interpret complex feelings and describe them. Finally, emotional management refers to the ability of monitoring and regulate own and other's emotions in a way that promotes personal growth (Mayer et al., 2008). There is incipient evidence that such emotional training helps to reduce negative emotions stress in highly uncertain situations without a clear solution, such as being a long-term unemployed individual within a recessive context (Hodzic, Ripoll, Lira, & Zenasni, 2015). Thus, although we believe that a context-based training is highly effective to sustain emotional regulation by reducing uncertainty within familiar theaters of operations, developing SFPs' emotional competencies may be a more *flexible* coping strategy within uncertain scenarios.

Finally, existing psychosocial SIS interventions focus on external social support as a way to enhance reactive coping mechanisms. LEO missions rely on real-time (synchronous) communication using a "CAPCOM buddy", which means having a former astronaut handling direct communication with astronauts (Caldwell, 2006). Although this approach works very well for LEO, where communication is synchronous, it may become obsolete when human spaceflight shifts from LEO towards future long-term missions. The unavoidable connection lag between Earth and the spacecraft will force communication exchanges to be asynchronous, that is, with a temporal delay between emission and response (De La Torre et al., 2012). In this regard, Media Synchronicity Theory (Dennis, Valacich, Speier, & Morris, 1998) posits that when using a communication media for socially related activities (e.g., group work), an elevated level of synchronicity enhances the positive outcomes of social interactions. The opposite occurs for asynchronous communication, which reduces its efficacy as a coping mechanism. It follows then that SIS interventions based on social support for long-term manned spaceflight should ideally be *autonomous* from Earth mission control.

The case for a psychosocial intervention to manage spaceflight-induced stress

The potential issues of existing SIS interventions reviewed above call for a *non-invasive*, *flexible,* and *autonomous* solution. We propose a SIS intervention that is compatible, and, to some extent, complements existing SIS interventions. Our intervention has the form of a training program that can equip astronauts, but mainly SFP, with emotional self-regulation and coping techniques to deal with Spaceflight-induced stress individually and collectively.

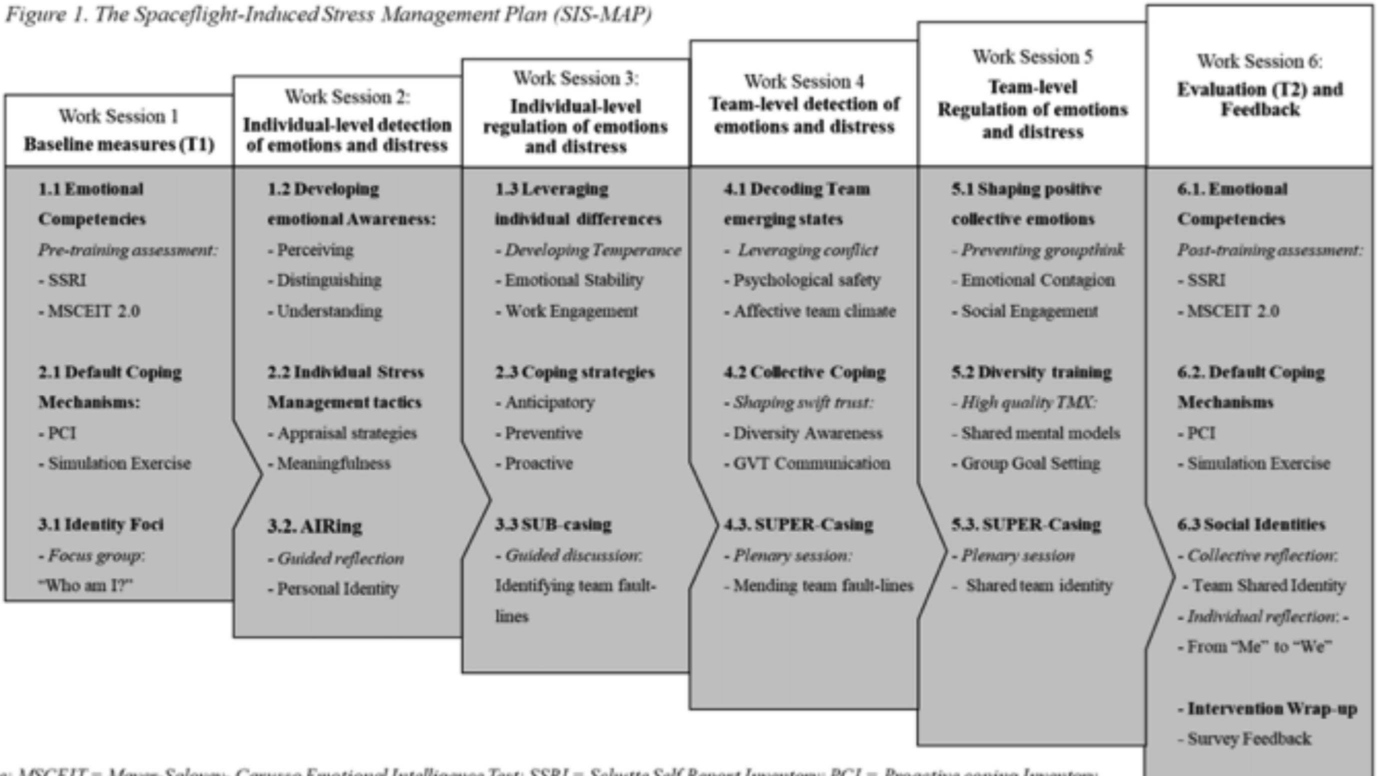
Our SIS intervention is informed by recent advances in social and applied psychology. First, stress coping research has evolved from purely reactive coping strategies into proactive, anticipatory, and preventive coping strategies. While reactive coping deals with a particular harm, loss or threat once it has occurred, anticipatory coping deals with immediate expected threats, preventive coping deals with an uncertain expectation of threats in the distant future; proactive coping reflects efforts to build up general psychological resources that facilitate achievement of challenging goals and personal growth (Schwarzer & Knoll, 2011).

Second, recent empirical research has shown that emotional competencies can be trained (Hodzic et al., 2015), and that such training reduces subjective stress and improve social relationships (Kotsou, Nelis, Gregoire, & Mikolajczak, 2011). More precisely, emotional competency training can increase quality-of-work-life reports (Cherniss & Adler, 2000; Slaski & Cartwright, 2003), and positively impacts team performance (Turner & Lloyd Walker, 2008). Finally, research social identity shows that a strong team identity enhances the ability of social support to reduce individual stress (Frisch et al., 2014), and even reduce cortisol and testosterone levels without any additional medication (Häusser, Kattenstroth, van Dick, & Mojzisch, 2012). In consequence, integrating activities that develop proactive coping behaviors, emotional competencies, and that foster social support into a training program respects the aforementioned design requirements of non-invasiveness, flexibility, and autonomy.

The Spaceflight-Induced Stress Management Plan (SIS-MAP)

The Spaceflight-Induced Stress Management (SIS-MAP) is a short, group-based training program aimed at prospective astronauts and SFP. The SIS-MAP comprises three modules divided into three phases and conducted through-out 6 work sessions: a training need analysis (work session 1), the actual training sessions (work sessions 2-5), and a training evaluation and feedback phase (work session 6). The first module develops emotional competencies, the second provides training about proactive stress coping techniques, and the third module focuses on developing social support mechanisms through the development of an organic, shared identity that improves both individual and collective coping (Rodriguez, Kozusnik, Peiró, & Tordera, 2019). Figure 1 shows a summary of the SIS-MAP, its components and main activities of each work session.

Figure 1. The Spaceflight-Induced Stress Management Plan (SIS-MAP)



Note: MSCEIT = Mayer-Salovey- Carusso Emotional Intelligence Test; SSRI = Schutte Self Report Inventory; PCI = Proactive coping Inventory

Phase 1: Training need analysis

As in any other intervention, the SIS-MAP requires from facilitators to establish first, baseline scores for emotional competencies and determine default coping mechanisms for each participant, as most individuals tend to differ in their innate ability to regulate their emotions, and how they instinctively cope with distress (Gross & John, 2003). Thus, in a first work session, facilitators should determine participants' baseline levels for (a) trait-like emotional competencies (EC module); (b) default stress coping strategies (Stress coping module); and (c) previous personally-valued social identities (Social Identity Module).

Psychometric tools are practical and cost-effective alternatives to determine individual variation in the aforementioned criteria. However, we recommend only utilizing instruments which are valid and reliable for participants from countries across the globe (i.e., the most likely team configuration of a long-term spaceflight mission). For example, the Schutte Self-Report Inventory (SSRI; Schutte et al., 1998) is a 33-item self-report measure of emotional competencies (e.g., perception, understanding, and management of emotions; Mayer, Roberts, & Barsade, 2008) that has been validated across national cultures. Similarly, the MSCEIT 2.0 is an instrument that uses a behavioral approach to measure emotional competencies (Mayer, Salovey, Caruso, & Sitarenios, 2003). Second, for assessing anticipatory, preventive and proactive coping strategies, we would recommend the Proactive Coping Inventory (PCI), which has also been cross-culturally validated and is already available in multiple languages (Greenglass, Schwarzer, & Taubert, 2007). Finally, the ASPIRe model (for a detailed explanation see Haslam et al., 2003) has been applied in multi-cultural environments. The ASPIRe intervention contributes to the formation of a collective identity and has been linked to reduced intra-group conflict and social support in confined environments (Haslam & Reicher, 2006). The ASPIRe model suggests conducting guided discussions groups to grasp participants' personal identification foci. The main goal of conducting such guided discussion is to raise awareness and foster in participants' a profound reflection about their identity, their inner values, but also bring into mind what are their valued social identities. The quality and depth of such initial reflection are essential to ensure the success of subsequent steps (AIRing, Sub-casing, Super-casing, and ORGanizing).

Phase 2: Training sessions

The emotional competencies (EC) module

The EC module is divided into four informative stages, and each stage serves as background for learning about and enhancing a particular emotional competence. For example, the goal of work session 2 for the EC module is to help participants to gain awareness of their emotional states by perceiving, distinguishing, and understanding emotions. Some examples of activities involve guided meditation, mindfulness exercises but also a conscious reasoning about one's emotions (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007; Hülsheger, Alberts, Feinholdt, & Lang, 2013).

The goal of work session 3 for the EC module is to strengthen participants' individual management of emotions. Thus, in what refers to managing emotions, we would provide participants with techniques that allow achieving (or restoring) an inner, positive emotional state. To this end, we would train SFP on how to tap into two personal resources, participants' Emotional Stability, and their Temperance. Whereas emotional stability is an inherited personality trait, a myriad of studies suggest it relates to psychological well-being (DeNeve & Cooper, 1998), and task performance under temporal pressure (Monzani, Ripoll, & Peiró, 2014). Instead, Temperance is a character dimension that is informed by stable traits such as emotional stability but also can be actively developed through training activities (Crossan et al., 2017). Participants will learn how to draw from their psychological capital and utilize it proactively to invigorate themselves immerse into their individual tasks with energy and dedication during the mission, or in other words, engage in their work. Work engagement is a strong predictor of individual performance but, more importantly, it is a major protective force against stress and burn-out (Salanova, Agut, & Peiró, 2005; Schaufeli, Salanova, González-Romá, & Bakker, 2002).

The goal of work session 4 for the EC module is enabling participants to decode their team's affective emerging states. Combining individual emotional regulation with collective emotional regulation, because not only the individuals that conform a workgroup have to deal with negative emotions, but the workgroup itself requires to solve their relational conflicts before they can act effectively as a team (Kozlowski & Ilgen, 2006). Recent studies show that collective emotional regulation can be attained either in face-to-face contexts (Curşeu, Pluut, Boroş, & Meslec, 2015) or across computer-mediated communication (Chmiel et al., 2011; Malone & von Ahn, 2012), two likely work environments in a long-term spaceflight mission. However, collective emotional regulation requires, as precondition, the emergence of collective psychological states, such as psychological safety climate, so that team members can "open up" to their peers without fear of backlash (Edmondson & Lei, 2014).

Finally, the goal of work session 5 for the EC module is to enable participants to shape positive collective emotions. We propose that a positive, collective emotional regulation can be attained through two mechanisms, mainly positive emotional contagion (Bono & Ilies, 2006) and social engagement (Tomaka, Thompson, & Palacios, 2006). Both mechanisms draw on their team members' individual and collective psychological capital to foster positive group attitudes. Once a positive affective climate emerges, the positive climate should elicit in other team members hope and optimism, and foster group affective outcomes, such as reduced interpersonal conflicting, especially when working in a virtual work environment (Lira, Ripoll, Peiró, & González-Navarro, 2007; Lira, Ripoll, Peiró, & Zornoza, 2013).

The stress coping module

The *stress coping module* would equip participants with anticipatory, proactive and preventive coping strategies, and inform them how to identify and prevent potential stressors. Further, this module aims to reduce social sources of stress, foster psychosocial protective factors such as social support to counter the effect of microgravity of group dynamics. Work session 2 aims to enhance participants' individual stress appraisal style. One particularly relevant activity for every SFPs is raising awareness of the meaningfulness of the forthcoming spaceflight mission. In this context, meaningfulness refers to a person's feelings that the tasks being carried out in given role are connected to something greater that provides a purposeful service to society at large (Emmons, 2003; Pratt & Ashforth, 2003). Prior studies show that creating meaningfulness for a stressing activity increases people's work engagement with such activity (Cartwright & Holmes, 2006). Thus, we propose that a strong sense of meaning can serve as an important psychological resource to deal with inherently stressful environments (Glazer, Kozusznik, Meyers, & Ganai, 2014), such as a long-term spaceflight mission.

The goal of work session 3 for the stress coping module is to provide SFP with individual coping strategies. To this end, facilitators would provide information on anticipatory, preventive, and proactive coping strategies, and create awareness when they would be more appropriate. After having identified participants' "default" coping strategy in work session 2, facilitators would now explain how to change the referent from the negative to the positive aspects of the demanding and difficult situations. Such changes in referent would, in turn, enable participants to appraise difficult situations as sources of challenge and opportunity (Kozusznik, Rodríguez,

& Peiró, 2015). Ideally, for the experiential learning component of the stress management block, participants would replicate highly stressing events that may occur in long-term human spaceflight within a controlled environment, like a virtual-reality simulator (Blue et al., 2017), or a real scale model of an ISS module, as it exists in ESA's ESTEC center. We also envision that once the ISS reaches the end of its lifespan, if could be reconverted to become the ultimate SIS training environment.

The goal of work session 4 for the stress coping module is to provide participants with strategies for collective coping of stress. This work session would include stress management activities be focused on preventing "culturally-induced" distress. To this end, facilitators should encourage the emergence of both *swift* and inter-personal trust. Team-building exercises focused on strengthening the quality of a team's relational exchanges (TMX) facilitate the emergence of trust (Jarvenpaa & Leidner, 1998; Martínez-Tur & Peiró, 2009; Zornoza, Orengo, Ripoll, González Navarro, & Peiró, 2007). TMX focuses on the horizontal relationships among team members (TMX; Seers, 1989). Second, this block's activities would then seek to optimize the flow of intercultural communication in GVT. More precisely, a first activity would include didactic approaches for dealing with the team's diversity, following Dubé and Robey (2009), and Malhotra, Majchrzak and Rosen (2007) recommendations.

The goal of work session 5 for the stress coping module is to provide participants with tools to reduced "diversity-induced stress". To overcome the natural culture fault-lines that emerge in any multi-national team, facilitators should encourage participants to construct a shared understanding regarding aspects of their collective tasks (available equipment, task requirements, success criteria for coordinated action; Tannenbaum, Salas, & Cannon-Bowers, 1996; Zaccaro, Rittman, & Marks, 2001). Such collective understating is paramount for multinational teams to work effectively (for a review see Chatman, Polzer, Barsade, & Neale, 1998). Similarly, in work session 5, participants should shift from creating the conditions for group-level trust and low quality TMX, towards strengthening it by developing high-quality team-member exchanges (TMX). High-quality TMX predicts increases in positive attitudes (e.g., satisfaction and commitment; Banks et al., 2014). TMX seems appropriate for a long-term human spaceflight mission, in which, as a result of national diversity, each SFP is likely to bring a unique degree of expertise into the mission, and as such is also very likely to expect to participate actively in the mission's decision-making processes.

The Social Identity module

The Social Identity module would draw on the well proven Actualizing Social and Personal Identity Resources intervention (ASPIRe; Haslam et al., 2003). In general, this module explores which social identities participants use to define themselves (e.g., nationality, gender, religion). During work session 2, facilitators should focus on identifying which social identities are relevant to a person (AIRing). Because an individual may have many social identities which are not all relevant to a given context (in this case, a space-flight mission), the facilitator should play an important role in framing this process within the mission's overall agenda. To this end, facilitators should highlight those identities which are functional to the spaceflight mission mandate (i.e., if a participant has a strong national identity, then highlighting the pride in representing one's nation in space activities).

Work session 3 would focus mainly on the second step of the ASPIRe program (SUB-casing). Sub-group caucusing consists in providing a separate space for participants who share similar worldviews and goals to think and communicate ways to contribute to the overall mission's mandate. The underlying process within this stage is called group consensualization, and it enables social support (Haslam et al., 2003). The main challenge for facilitators in this step is preventing the polarization of sub-groups.

Work session 4 of the ASPIRe module would focus on superordinate consensualizing, or Super-Casing. After identifying the subgroups in the prior step, facilitators would invite one or more members of each subgroup to represent their subgroup in a debate. Even though the process of overcoming barriers appears similar to the previous sub-casing stage, the main difference resides in that a larger, shared identity should develop as a result of the super-casing stage. Such shared identity would cohesively unite the subgroup identities into a shared, mission-driven identity, which would not be uniformly imposed but organically developed as result of participants' diverse inputs.

Finally, work session 5 focus on the fourth step of the ASPIRe framework, Organic Goal-setting (ORGanizing). In short, ORGanizing refers to empowering participants to harmonize the emerging shared supra-ordinary goals with, in this case, the actual spaceflight mission mandate. Such alignment provides participants a sense of voice, which can inform team leaders about their crews' aspirations without undermining team leaders' formal authority. Extant research also shows that such participative approach results in higher levels of social support and collective performance in both face-to-face and virtual work environments (Picazo, Gamero, Zornoza, & Peiró, 2015; Wegge, Bipp, & Kleinbeck, 2007).

Phase 3: Training evaluation and feedback to participants

In the training evaluation phase, facilitators would (1) conduct a post-training assessment, (2) provide personalized feedback, (3) encourage self- and collective reflection. First, the above-proposed measures would be administered again to collect the second measurement of emotional intelligence and stress coping strategies. Contrasting this second measurement to the first measurement (baseline) would allow determining to some extent the efficacy of the SIS-MAP intervention. However, due to high-stakes involved in human spaceflight, we strongly advise to triangulate such report measures with facilitators' observations during the whole training program, and how participants responded to the ASPIRe intervention. In this way, by incorporating self and other reports, facilitators increase the robustness of the final assessments. To conclude, facilitators would provide each participant with feedback on how much they improved (or not) during the SIS-MAP training.

CONCLUSION

Although long-term spaceflight has caught the attention of the general public and continues to be a constant source of inspiration for psychologists interested in team effectiveness (Salas et al., 2015), spaceflight-induced stress is still a major obstacle for extended human spaceflights. We emphasize the importance of using proactive stress coping strategies, developing a shared social identity, as well as intercultural and emotional competencies, as non-invasive techniques that could contribute to reduce spaceflight-induced stress. The use of these coping techniques would strengthen social support, develop trust, and improve communication among crew members, and SFP. Thus, astronauts and SFPs need to conquer spaceflight-induced stress before a manned mission to Near Earth Objects (NEO), or even Mars can become a viable reality.

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