Univerzita Karlova

Filozofická fakulta

Katedra psychologie

Bakalářská práce

Lucie Davidová

Vnitroskupinové konflikty týmů v extrémních podmínkách – analýza a identifikace jejich příčin

Intragroup conflicts of teams in extreme conditions - analysis and identification of their causes

Praha, 2017 Vedoucí práce: doc. PhDr. Milan Rymeš, CSc.

Poděkování

Ráda bych na tomto místě poděkovala několika lidem, kteří mi významně pomohli přiblížit se svým snům týkajících se výzkumu v oblasti vesmírné psychologie. Prvním z nich je Dr. Sýkora, kterému tímto děkuji za milou spolupráci, optimismus a neuvěřitelný zápal do práce, kterou jsme si vytyčili. Je mi velkou inspirací a vzorem jak po pracovní, tak i lidské stránce. Můj vřelý dík zasluhuje také doc. PhDr. MUDr. Mgr. Radvan Bahbouh, Ph.D., kterému jsem vděčná za to, že mě od samého začátku podporoval v mých výzkumných vizích jakkoli byly šílené, a poskytl mi mnoho cenných rad. Do třetice bych chtěla poděkovat MSc. Agatě Marii Kołodziejczyk PhD., že mi dala možnost se realizovat v jejích projektech a odstartovala tak pro mě zcela novou životní etapu plnou neskutečných výzev i společných zážitků a radostí.

V neposlední řadě si můj obrovský dík zaslouží vedoucí mé práce doc. PhDr. Milan Rymeš, CSc. za jeho vřelý lidský přístup, kterým mě podporoval při tvorbě této práce a humorný optimismus, kterým mě zahrnul, když se blížil termín odevzdání.

Prohlášení

Prohlašuji, že jsem bakalářskou práci vypracovala samostatně, že jsem řádně citovala všechny použité prameny a literaturu a že práce nebyla využita v rámci jiného vysokoškolského studia či k získání jiného nebo stejného titulu.

V Praze dne 15.5. 2017 ………………………

Lucie Davidová

Abstrakt

V současné době, kdy byly představeny ambiciózní projekty budoucích vesmírných misí s lidskou posádkou jako jsou „Moon Village“, nebo mise k Marsu, výzkum zabývající se psychosociálními aspekty týmů v extrémních podmínkách vyžaduje značnou pozornost. Zatímco v normálních podmínkách, kde vnitroskupinový konflikt a selhání obvykle nezpůsobí nic závažnějšího než těžkosti a nepohodlí, v extrémních podmínkách může mít fatální konsekvence.

Hlavními cíli této práce jsou: hlubší porozumění specifickým aspektům a výzvám týkajících se spolužití lidí v extrémním prostředí, identifikace psychosociální problémy, které mohou způsobovat vnitroskupinové konflikty a tenzi uvnitř týmů a hledat jevy opakující se napříč studiemi. Takováto znalost je zásadní pro vytváření preventivních opatření a postupů protiopatření pro budoucí projekty, jako i pro vývoj výzkumné metodologie.

Výsledky uplynulých výzkumů v této oblasti byly sumarizovány v několika kapitolách, které jsou zaměřeny na metodologii uplynulých výzkumů, příčiny vnitroskupinových konfliktů zaměřené na specifické faktory, které ke konfliktům v týmech pobývajících v extrémních podmínkách přispívají, a možnosti preventivních opatření.

Závěrečná empirická část představuje návrh výzkumu, který je založen na poznatcích z teoretické části. Tento kvalitativně zaměřený výzkumný design si dává za cíl syntetizovat výsledky získané ze čtyř metod, jimiž jsou: sociomapování, zaměřené pozorování, zakotvená teorie vnitroskupinové komunikace a obsahová analýza, tak aby bylo dosaženo komplexního vhledu do problematiky týmové dynamiky a vnitroskupinových konfliktů týmu v extrémních podmínkách.

Klíčová slova

Interpersonální konflikty, extrémní podmínky, dlouhodobé vesmírné mise, izolace

Abstract

Since ambitious projects of future human space exploration such as Moon Village, or crewed mission to Mars, were introduced, research on psychosocial aspects of teams in extreme conditions deserves greater attention than ever before. Unlike normal environment, where intragroup conflicts usually cause no more than difficulties and discomfort, such aspects may have fatal consequences if occur in extreme conditions.

The main objectives of this work are: to deeply understand the specific aspects and challenges of human cohabitation in an extreme environment, to identify psychosocial issues that may produce intragroup conflicts and tension within teams, and to the search for the main psychosocial phenomena and issues recurring over studies. Such knowledge is crucial for developing preventive provisions and countermeasure strategies for future projects, as well as designing a suitable research methodology.

The findings gained from previous research in this area were summarized within several sections including methodology of past research, prevention of intragroup conflicts that focuses on specific factors contributing to conflicts of teams in extreme conditions, and possibilities of prevention.

Finally, the empirical part of this thesis involves the research proposal based on the knowledge from theoretical part. This qualitatively oriented research design aims to synthesize results gained from several methods, namely: sociomapping, focused observation, grounded theory of intra-crew communication, and content analysis of interviews in order to provide complex insight into the problematics of the team dynamics and intragroup conflicts of the team in extreme condition.

Key words

Interpersonal conflicts, extreme conditions, long-term space missions, isolation

Obsah

Acronyms and Abbreviations

CapCom	Capsule communicator
DLR	German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt)
EAC	European Astronaut Center, ESA
ESA	European Space Agency
EVA	Extravehicular activity
EXEMSI	Experimental Campaign for the European Manned Space Infrastructure
FMARS	Flashline Mars Arctic Research Station
HFACS	Human Factors Analysis and Classification System
HUBES	Human Behavior in Extended spaceflight
IAC	International Astronautical Congress
IMBP	Institute of Medical and Biomedical Problems (Институт медико-биологических проблем)
ISEMSI	Isolation Study for the European Manned Space Infrastructure
ISS	International Space Station
M.A.R.S.	Modular Analogue Research Station
MCC	Mission Control Center
MDRS	Mars Desert Research Station
NASA	National Aeronautics and Space Administration
NEK	Ground-based Experimental Facility (НЭК, Наземный экспериментальный комплекс)
PI	Principle investigator
PMAS	Poland Mars Analogue Simulation 2017
PSPA	Personal Self-Perception and Attitudes (computerized test based on repertory grid technique) for more details see (Gushin & Vinokhodova, 2010)
RQ	Research question
SFINCSS-99	Simulation of Flight of International Crew on Space Station
SEPG	Space Exploration Project Group
SYMLOG	System for the Multiple Level Observation of Groups (developed by Bales and Cohen) see (Bales, Cohen, & Williamson, 1979)

Introduction

Work teams, their optimization, effectiveness, performance, dynamics, and the relationships among team members have always attracted attention of many experts. This specific area represents important complex field of study that interferes to the social psychology, psychology of work and organization, and psychology of personality. The proposed thesis deals with a specific part of this area - psychosocial aspects regarding teams in extreme conditions and their internal conflicts. The cohabitation of human beings in hostile environments is associated with countless number of risks and challenges that one must continuously cope with. How people cope with harsh conditions? How to prepare astronauts for long-term interplanetary mission? Where are the boundaries of what may a human be capable of? What psychological support would be useful to provide them and how?

There are many challenges not only for subjects, but also for psychologist who aim to understand all the possible aspects regarding these specifics and to capture them scientifically. For me personally, this area represents a fascinating challenge full of riddles that have not been solved yet, a space, where I can contribute. The knowledge gained from past studies is not united, many key questions have remained without clear answers so far, e.g. how to design a suitable research design for investigation of a team dynamics including team cohesion and intragroup conflicts, how to mitigate an impact of stressors to human well-being, what effects has the presence of a woman on team dynamics, how to select astronauts for interplanetary missions, how would people react to the long-term loss of visual contact to the Earth, etc.

The proposed thesis summarizes the findings gained from previous research in the field of psychology of teams in extreme conditions with an emphasis on space crews because space-related research represents field of study that is rich in scientific experiments performed as well as in currently running research projects. Special effort is given to the comprehensiveness of information with an aim to find the main psychosocial phenomena and issues recurring over studies. Other goals of this thesis include deep understanding of the aspects specific for isolated teams, and to identify psychosocial issues that may produce intragroup conflicts and tension within teams staying in harsh and risky conditions. Such knowledge is crucial for developing preventive provisions and countermeasure strategies for future projects, as well as designing a suitable research methodology. From previous work (Davidová, 2016a, 2016b) it is known that in spite of various methods and methodology applied in past projects, there is still possibility of improvement in terms of methodology and methodics applied. Complex research designs including an instant analysis and early detection of conflicts directly connected to intervention procedures and psychosocial support, would be very beneficial for efficient team optimization in future not only space-related projects. Empirical part of this work strives to provide such research design while taking in account the knowledge and lessons learned from the theoretical part. Proposed research design offer qualitative approach to the crew dynamics of a team simulating Mars mission with focus on intragroup conflicts. It involves several methods combining subjective and objective assessment to increase validity of findings.

I. THEORETICAL PART

1. Teams in extreme conditions

The definitions of a group and team are tricky, and varies across literature. Global definition for a *group* consist of three parts – some people, interaction, for certain time (Bußmann, 2014). Other major components of a group can be: common purpose shared values and shared norms (Haynes, 2012). The term *small social group* is not clearly defined in literature in scope of number of members. One of the suggested distinctions between small social group and big social group is defined by the ability of members inside the group to communicate among each other e.g. (Bahbouh, 2012). Distinction between a group and a team is often unclear (Brannick & Prince, 1997). Authors says that *group* has broader sense than *team* and has been applied to a higher number of social and organizational forms (Hackman, 1990). Literature offers many definitions and classifications of *groups* while defining *teams* is not frequent. Hackman (1990) states that teams are created to achieve certain goal. Bahbouh (2012) defines team as a small group of people who know each other and must interact for achievement of common goals. For the purposes of this work a *team* is number of people that mutually know each other, share some goals, and interact for certain time. Distinction between group and team will not will not be particularly important.

Other term significant for this work is an *intragroup conflict*. An intragroup conflict represents complex phenomenon which understanding requires comprehensive knowledge of underlying team's processes. There have been many theoretical and descriptive models developed to describe work team's processes, development, and conflicts e.g. (Dickinson & McIntyre, 1997; Kozlowski, n.d.; Salas et al., 2015; Wheelan, Davidson, & Tilin, 2003) and many papers strives to identify causes of intragroup conflicts because of its importance for optimizing work teams. However, the picture of intragroup conflict remains incomplete, there has been little systematic consideration of the linkages among individuals, dyads, and teams and there is no theoretical framework for understanding how group-level conflict processes influence dyadic and individual dynamics and how individual and dyadic processes shape intragroup conflict processes (Korsgaard, Soyoung Jeong, Mahony, & Pitariu, 2008). For the purposes of this work, an intragroup conflict is defined as a complex phenomenon caused by a discrepancy at the team-level area, that is perceived by a member (or members) of the team, and it negatively psychologically influences a member (or members) of the team with various level of impact on the team dynamics, mutual interactions, and overall team processes.

Dijkstra with colleagues found out that conflicts positively relate to responses of helplessness and "flight behavior" and these responses mediated the effects of conflict on experienced organizational stress (Dijkstra, 2006). A team's conflict in general have traditionally been associated with negative impact and thus have been studied with such approach e.g. (De Dreu & Weingart, 2003; Rubin, Pruitt, & Kim, 1986; Wall & Callister, 1995). Also the negative impact of a conflict to team's performance is known, although some authors point out that conflicts may have also positive, functional side (De Dreu & Weingart, 2003). Longitudinal study of work teams indicated that high performance groups were associated with a particular pattern of conflicts: low levels of relationship conflict (with a rise near project deadlines), moderate levels of task conflict at the mid-level of group interaction (Jehn & Mannix, 2001).

As seen, intragroup conflict is associated to the team processes. Dynamic relationship between performance feedback, trust, and conflict in groups was found in longitudinal study that brought an evidence that negative initial group performance feedback results in later increases in task and relationship conflict. Groups with high early intragroup trust are buffered from experiencing the worst of future relationship conflict (Peterson & Behfar, 2003). It is no surprise that conflicts inside work teams may cause serious troubles and difficulties. However, in extreme conditions, such as long-term manned spaceflight, any conflict or failure may become fatal (Horneck et al., 2003; Horneck & Comet, 2006).

An extreme environment is the one to which humans are not naturally, optimally adapted (Leach, 2016). Thus, when referring to the teams in extreme conditions, teams in an environment of certain specifics, particularly isolation and confinement with a various level of danger, are meant. Mostly three kinds of environments from which teams in extreme condition are researched are: astronaut[1] crews in space or space analogous conditions e.g. (Kanas, 2013, 2015; Kanas & Manzey, 2008; Kanas, Weiss, & Marmar, 1996; Palinkas, 2001; Sandal, 2001; Spring, 2010), polar stays or expeditions, teams floating on boats or submarines (Altman &

[1] There are several terms that are connected to certain nationality or space agency – an *astronaut* is American (or connected to NASA), a *cosmonaut* is Russian, and a *taikonaut* Chinese. However, for this thesis this distinction will not be considered, only the term *astronaut* is going to be used.

Haythorn, 2015; Nice, 1981; Weybrew, 1991). Studies of teams in polar areas are often associated to space research, because such environment is analogous to a space conditions (Harrison, Clearwater, & McKay, 1991; Leon, Sandal, & Larsen, 2011; Palinkas, 2003; Palinkas, Gunderson, Johnson, & Holland, 2000; Tafforin, 2004, 2005; Zimmer, Cabral, Borges, Côco, & Hameister, 2013). Therefore, present thesis pays special attention to the studies regarding space exploration. Since ambitious projects regarding future human space exploration, such are: Moon Village (Foing, 2016; Woerner, n.d.; Woerner & Foing, 2016), crewed mission to Mars (Barker, 2015; Horneck et al., 2006; Salotti & Heidmann, 2014), and exploration of near Earth objects (Chappell, Abercromby, Todd, & Gernhardt, 2011; NASA, 2011; Reagan, Janoiko, Parker, & Johnson, 2012; Todd & Reagan, 2003), were announced, research on psychosocial aspects of an astronaut crew is becoming to be an increasingly important issue requiring great attention (Kanas et al., 2009; Manzey, 2004; Palinkas, 2001; Sandal, 2001; Ursin, Comet, & Soulez-Larivière, 1992).

2. Extreme conditions

Humans are highly resistant and adaptable to the most environmental conditions although life and work in an extreme environment is a constant challenge to the health and well-being of individuals (Mullin, 1960). An extreme or abnormal environment is the one to which humans are not optimally adapted even though can accommodate through the development of coping strategies (Leach, 2016). When refer to the work teams in extreme conditions, it is an environment of certain specifics, mainly isolation and confinement with a various level of danger. However, danger, and hardship may not be the most significant stressors. Mullin (1960) found out that the most important psychological stress of an isolated group in Antarctica was the problem of individual to adjust to the group.

There are several kinds of corresponding environments where teams in extreme environments have been studied. Most of such studies were conducted as a part of space research, e.g. stays on the Mir and ISS (Kanas, Salnitskiy, Ritsher, et al., 2007; Kanas, Gushin, & Yusupova, 2008) and Earth based analogue space simulations e.g. (Davidová, 2016b; Mohanty, Fairburn, Imhof, Ransom, & Vogler, 2008; NASA, 2011; Salas et al., 2015; Schlacht, Foing, et al., 2016; Suedfeld, 2010). Apart from that, studies from polar expeditions (Bechtel & Berning, 1991a; Leon et al., 2011; Lugg & Shepanek, 1999; Muller, Lugg, Ursin, Quinn, & Donovan, 1995; Palinkas, 2003; Palinkas & Suedfeld, 2008), and naval teams on boats or submarines (Altman & Haythorn, 2015; Nice, 1981; Weybrew, 1991) can be found. Research of polar expeditions is often connected with space research because the conditions teams experience there, are in many ways analogous to the conditions of a space mission (Bishop, 2011; Harrison et al., 1991; Leon et al., 2011; Palinkas, 2003; Palinkas et al., 2000; Tafforin, 2004, 2005; Zimmer et al., 2013). Materials corresponding to the aforementioned scenarios will serve as a source of information for this review with special attention to space research. Some of the significant past and current projects will be briefly presented.

2.1 Space expeditions

Six astronauts typically attend international Space Station. Stay at ISS in average lasts 166 days. The longest stay of a human at ISS was 340 days long (NASA, n.d.-c; Wikipedia, n.d.). Space station Mir recorded two even longer missions. The longest human spaceflight was achieved by Valery Poljakov and took 437 days.

Manned mission to Mars is currently a hot topic, especially after Elon Musk's speech, who pointed out at IAC 2016 that sending people to Mars is possible in our lifetimes (Musk, 2016). Mission to Mars represents one of the main targets of the current development of space exploration, and much research is focus on it, thus needs to be described.

Manned mission to Mars has been planned to be conducted in first half of this century or formerly (Bennahum, 1997; Horneck et al., 2003, 2006). Manzey (2004) mentions first suitable study of human mission to Mars published in 1953 by Von Braun (Von Braun, 1953). First reviews on psychosocial aspects of long term spaceflight were published between 1970's and 1980's (Manzey, 2004).

The length of the future mission to Mars has two possible scenarios depends on the time spent on the Mars surface. The first would last around 520 days with 30 days stay on Mars surface while the second would take 1000 days with 525 days spent on Mars surface (Horneck et al., 2006). Both mentioned scenarios mean considerably longer stay of human beings in space than it has ever been achieved. It implies a need for deep knowledge of psychosocial aspect of long-term cohabitation in isolated and confined area research (Kanas et al., 2009; Manzey, 2004; Palinkas, 2001; Sandal, 2001).

2.2 Space-like environment

Space agencies and other institutions conduct analog missions or spaceflight simulations to gain further understanding of certain issues relevant for space research. These projects aim to imitate space conditions on Earth. Analog missions are implemented to solve the unique challenges of cohabitation and working of humans in extreme environments (NASA, n.d.-e; Reagan et al., 2012). Admittedly, such experiments cannot fully simulate space expeditions. For example, microgravity (or lower gravity as on Moon or Mars) cannot be simulated terrestrially for longer than dozens of seconds, analogue astronauts on Earth cannot be exposed to space radiation etc. (Bell, Outland, Abben, & Brown, 2015; Salotti & Suhir, 2014). Moreover ethical standards (Declaration of Helsinki and human rights) prohibit conditions such as offering no evacuation in case of emergency, no possibility of withdrawal from the experiment etc. (Manzey, 2004). Despite these limitations, analogue studies can provide valuable insight to the cohabitation of human beings in space and other extreme environments (Herian & Desimone, 2014; Schlacht, Foing, et al., 2016). Diego and Urbina (2014), Mars 500 astronauts, who have simulated a 520 days long journey to Mars and back, pointed out that it is a common misconception among external people that in isolation projects the crew feels like they can end the simulation at any time and go home with little or no consequences.

There are several kinds of analogs. Expeditionary analogs (e.g. oceanic, polar, desert, caving, mountaineering) are characterized by moving from one place to another rather than inhibiting a locale. Historical expeditions were typically long lasting (i.e. months to years) characterized by significant known and unknown risks and broad goals. Modern expeditions, in contrary, which are typically shorter (i.e. two weeks to three months), utilize the advantages of technology to minimize risks (e.g. weather forecasts, satellite communications to maintain contact). They are also more goal-oriented, task-focused, and involve members with specialized roles and skills. Psychosocial research on teams can be involved as a secondary to expedition goals, personal goals, schedules, and contingencies (Bishop, 2011).

Another option represents chamber scenario. Bishop (2011) mentions that the first systematic attempts to investigate psychological adaptation factors to isolation and confinement in simulated operational environments were conducted between late 1960s and early 1970s by putting volunteers in closed rooms for several days. Subjects had to undergo sleep deprivation and/or various levels of task demands.

One of the early isolation experiments regarding human space exploration was Štola-88, an experiment conducted by Czechoslovak Academy of Sciences in 1988 in near Tišnov, Czech Republic led by Dr. Sýkora (Sýkora, 1989; Sýkora, Dvořák, Bahbouh, Bernardova, & Justa, 2010). This project was unique in many ways and inspired researchers for designing future isolation experiments (from private interviews with Dr. Sýkora). The most famous, and important for this thesis, will be mentioned.

Couple of experiments - ISEMSI and EXEMSI conducted by ESA were done at 1990 and 1992. Both studies simulated long-term spaceflight. ISEMSI was comprised of 6 crewmembers that were in isolation for 28 days. EXEMSI was attended by 4 member-crew and took 60 days (Collet & Vaernes, 1996; Vaernes, 1996; Værnes, 1996; Vaernes, Schernhardt, Sundland, & Thorsen, 1993). In parallel with EXEMSI the Biosphere 2 was conducted. It was a large ambitious 2 years long project (conducted 1991-1993) where team of eight subjects (four women and four men) have been sealed inside the 3.15-acre ecosystem in Arizona. This ecosystem was materially closed, with air, water, and organic material being recycled. It intended experimental life researching ecological self-organization and integrating humans, technology and agriculture (Nelson, Gray, & Allen, 2015; Walford et al., 1992).

In 1994 Russian experiment of Mir space station simulation - HUBES was conducted similarly as ECOPSY one year later (Gushin et al., 1997; Gushin, Efimov, Smirnova, Vinokhodova, & Kanas, 1998; Kanas, 2013; Mohanty et al., 2008). Later on, at 1999 SFINCSS-99, the multinational simulation of ISS stay, was executed in Russia (Inoue, Matsuzaki, & Ohshima, 2004).

Relatively recent experiments Mars 105 Mars 520 were conducted 2009 and 2010 in complex NEK at Moscow. Mars 500 was the first Earth-based, high-fidelity simulated mission to Mars where the multinational crew of 6 healthy males was confined in a 550 m^3 chamber for 520 days (Basner et al., 2014; ESA, 2009, 2011; IMBP, n.d.; Spring, 2010; Šolcová, Stuchlíková, & Guščin, 2014; Vinokhodova, Gushin, Eskov, & Khananashvili, 2012).

2.3 Current research

Several well-known projects and facilities will be mentioned in this chapter in order to provide brief overview about current research of teams in extreme conditions. Mars Society owns two habitats - Mars Desert Research Station (MDRS) in Utah, the USA; and Flashline Mars Arctic Research Station (FMARS) on Devon Island in Canada. These facilities regularly host crews for analogue studies (Binsted, Kobrick, Griofa, Bishop, & Lapierre, 2010; "The Mars Society," n.d.). Antarctic station Concordia was several times attended by scientists as a part of space research by ESA (Bishop, 2011). Another place where space mission can be simulated is HI-SEAS (Hawaii Space Exploration Analog and Simulation) that regularly host crew for long-term stays ("Hawaii Space Exploration Analog and Simulation," n.d.). NASA currently runs series of analog experiments called HERA (Human Exploration Research Analog) (NASA, n.d.-b). EAC (European Astronaut Center) together with DLR (German Aerospace Center) are building FLEXhab - the Future Lunar Exploration habitat based Cologne, Germany (Schlacht, Punch, et al., 2016). Russian IMBP announced new series of isolation studies in complex NEK that will start at autumn 2017 (IMBP, 2017; Orlov, Belakovsky, & Ponomarev, 2016). Finally, new habitat called Modular Analog Research Station (M.A.R.S.) is being built in Poland. This habitat will serve as a research facility for Moon/Mars analog missions ("M.A.R.S. Modular Analog Research Station," n.d.; Schlacht, Foing, et al., 2016; Schlacht, Punch, et al., 2016). Testing mission including psychosocial investigation was already conducted at August 2016 (Davidová, 2017) and two new projects – Lunar Expedition 1 and Poland Mars Analog Simulation (PMAS) ("Poland Mars Analogue Simulation 2017," n.d.) are going to be conducted during summer 2017.

3. Identification of intragroup conflicts

This section focuses on methods and research designs of past studies that targeted to assess intragroup conflicts of teams in extreme conditions. An intragroup conflict is complex phenomenon that involves processes of team's dynamics, as described above, when defining an intragroup conflict. Therefore, the question what concrete aspects should be studied and what methods to apply, arises. Team processes, such as interpersonal interactions, team's dynamics, communication among team members, cooperation, and team's development, are involved in an intragroup conflict. And there is another very complex term - group dynamics, that because of its complexity indicates a challenge for research (Salas et al., 2015).

Group dynamics, in one of the definitions, is created by the interactions inside the group (Prada, Ma, & Nunes, 2009). There is a linkage between interaction and communication is obvious when investigating intra-team processes through which identification of conflicts can be made. *Interaction* is very close to *communication* by its meaning. *Interaction*, in its definition, has wider meaning than *communication*. Communication is necessary component of an interaction (Janoušek, 1968) and can be assessed by several psychological methods (e.g. content analysis, sociomapping, etc.). Additionally, communication represents the main component of teamwork processes because it interferes with other teamwork processes (Dickinson & McIntyre, 1997). Consequently, methods studying communication are undoubtedly meaningful for identification of intragroup conflicts and a team dynamics.

Communication is closely linked to many other aspects of group´s dynamics and its performance. Communication has been found to be significant predictor of friendship intensity over time (Selfhout, Denissen, Branje, & Meeus, 2009). Similarly, Gottman can predict if a newly married couple will stay together based on observation of 15 minutes of a conversation of partners (Gottman & Silver, 2015) by using a method called Specific affect coding system (SPAFF) that he developed together with R. Levenson in 1975 (Coan & Gottman, 2007). Another approach offers Newcomb who studied the role of communication in the maintenance of friendship (Newcomb, 1956). He marked communication as the major interaction process through which individuals can reward one another (Lott & Lott, 1965). Communication frequency has also relation to perceived trust (Becerra & Gupta, 2003). Assessment of medical doctors indicating that doctors who communicated more frequently were considered more trustworthy by their colleagues (O'Reilly & Roberts, 1975). Additionally, efficient information exchange may enhance understanding among team members, thus reduce frictions, increase a crew´s effectiveness and support team cohesiveness (Reyes, Binder, & Kraft, 2004), in contrary, inappropriate communication may have a significant negative impact on teamwork processes, and can influence intragroup conflicts as investigated as a part of Mars 500 project. - Highly significant negative correlation between interpersonal communication of the crew and anxiety (r= -0.928; p=0.008) was found (Tafforin, Vinokhodova, Chekalina, & Gushin, 2015). Research on communication failures and misunderstandings indicated, that communication failures can end up fatally (Lingard et al., 2004; Winsor, 1988).

Communication is one of the significant components to be researched when investigating intragroup conflicts. Various methods have been used to identify potential intragroup conflicts within teams in extreme conditions, the overview of them will be listed below.

Interaction Process Analysis and SYMLOG, based on focused observation (in isolation studies traditionally from video recordings), was applied for example in ISEMSI and EXEMSI experiments. Video recordings were analyzed and intragroup communication patterns were displayed in charts (Sandal, 2001; Sandal, Vaernes, & Ursin, 1995; Sandal, Værnes, & Ursin, 1996). The limitation of observational methods is relatively difficult in execution (need of full attention of observers, previous experience with method etc.) and potential bias, different observers may not code the interactions equally (Janoušek, 1986).

Content analysis of communication within the team was applied, as a part of, for example, HUBES, ECOPSY, Mars 105, and Mars 500 (Gushin et al., 1997, 2012; Kimhi, 2011; Rosnet, Caves, & Vinokhodova, 1998; Shved, Gushin, Ehmann, & Balazs, 2013; Shved, Gushin, Vinokhodova, Nichiporuk, & Vasilieva, 2014; Ushakov et al., 2012), as well as research of submariners (Kimhi, 2011). However, there are certain limitations if applying for identification of intragroup conflicts. Relatively frequent is also analysis of logs and diaries from individual team members (Kass, 2015; Lebeděv, 1988; Reyes et al., 2004; Suedfeld, 2010).

Personal Self-Perception and Attitudes software (PSPA), is a computerized test based on Kelly’s repertory grid technique and Osgood’s semantic differential. It was designed to study small groups in isolation and confinement. It is based on analysis of the subjective attitudes of the subjects to themselves and others. Subject chooses assessment criteria by himself, answering the question: What are the main features (traits) that allow you differentiate people from your close surrounding? Then he has to estimate the extent of psychological similarity between himself and his team-mates (Gushin & Vinokhodova, 2010; Tafforin et al., 2015). PSPA was used especially in Russian studies: HUBES (Gushin et al., 1998), ECOPSY (Gushin et al., 1998), Mars 105 (Vinokhodova et al., 2012), and Mars 500 (Šolcová, Gushin, Vinokhodova, & Lukavský, 2013; Tafforin et al., 2015).

Sociometry is a classical method of social psychology that provides visualization of a group's relations based on preferences (Janoušek, 1986; Loomis & Pepinsky, 2015; Petrusek, 1969). Sociometry was used in several space-related studies (Sýkora, 1989; Tafforin et al., 2015; Vinokhodova et al., 2012).

Sociomapping (described in more details as a part of the section *6.2 methods* in this work) is a socio-diagnostic method that enables visualization of the crew's interactions, traditionally based on self-report questionnaires, even though data collected differently can be visualized too (Bahbouh, 1994, 1996, 2004, 2012). Sociomaps can capture development over the time for isolation including intragroup relations and group cohesion. Sociomapping was used in the following isolation experiments: HUBES, ECOPSY, Mars 105 and Mars 500 (Bahbouh, 1996, 2012; Bahbouh, Sněhotová, Děchtěrenko, & Sýkora, 2015a; Lačev, Srb, et al., 2012; Lačev, Sýkora, Bahbouh, Lukáš, & Höschl, 2012). Recently also in Lunar Expedition 0 (Davidová, 2017; Kołodziejczyk, Ambroszkiewicz, et al., 2017) or as a part of EVA simulation for assessing communicational issues (Harasymczuk et al., 2017). Moreover, other various self-report questionnaires applied for research of submariners (Kimhi, 2011; Wood, Lugg, Hysong, & Harm, 1999) etc.

4. Causes of intragroup conflicts: Specific factors affecting teams in extreme conditions

There are dozens possible causes of intragroup conflicts. Researches study the causes of intragroup conflicts usually in work teams in organizations (Jehn, 1997; Jehn & Bendersky, 2003; Wall & Callister, 1995). For example, Callister provides comprehensive list of the causes of intragroup conflicts that are grouped into three categories: individual characteristics (personality, values, goals etc.), interpersonal factors (distrust of others; communications: distortions and misunderstandings, high goals, dislikes, insults; behavior: blocking party's goals, power struggles; structure: closeness, low interaction; previous interactions etc.), issues (complex vs. simple, principled, size, divisibility etc.) (Wall & Callister, 1995, p. 518).

Searching for the causes of intragroup conflicts is important in context of human failures and their prevention. To fully address the causes and effects of human errors and conflicts holistic approach is required (Latorella & Prabhu, 2000), as is for example the multifaceted taxonomy of human errors that counts, such are subjective goals and intentions, mental load, resources, affective and situational factors, task characteristics, physical environment, work time characteristics, excessive task demand, decision making, intrinsic human variability, etc. (Rasmussen, 1982). Admittedly, there is many identified causes of intragroup conflicts as well as many research approaches. In consideration to the topic of this work, some of the factors contributing to the intragroup conflicts, that are specific for the extreme environments will be described in this chapter.

Teams in extreme conditions have to face many challenges in terms of psychological and psychosocial issues. Bell with colleagues (2015) mentions that the conditions of an extreme environment within which team members live and work together and the length of an expected mission may have a significant impact on social (e.g. team cohesion, psychosocial adaptation) and tactical (e.g. communication, cooperation, coordination) processes. The aspects also may serve as potential intragroup conflicts. The specific factors contributing to the intragroup conflicts that will be introduced in this chapter are: disruption of team's cohesion, problematic relationship between a crew and MCC, dissatisfaction with a diet, the proportion between men and women in a crew for long-duration space mission, and the aspects connected to the stress and adjustment.

4.1 Disruption of team's cohesion

Team cohesion is disrupted if the group split into two or more subgroups. Subgrouping is one of the phenomena that have occurred in many research projects. Slight subgrouping is present almost always as a natural process. For work tasks, it is beneficial to separate into subgroups in order to work on certain tasks. However, considering isolated small social group of 3 to 6 people (which is the number of crewmembers of most of the space-related isolation studies), if there are obstacles in communication and other team processes, it may lead to increased tension, scapegoating or other difficulties (Davidová, 2016b). Team structure also matters. Difficulties occur when subgrouping escalates into the development of cliques (Palinkas, 2003; Palinkas & Suedfeld, 2008; Stuster, 2000).

Two experiments - HUBES and ECOPSY were attended by three crewmembers. In both of these experiments the crew split into a dyad and one solitaire. Such team process led to increased level of intragroup tension (Bahbouh, 2012; Gushin, Efimov, Smirnova, & Vinokhodova, 1996; Gushin et al., 1998; Rosnet et al., 1998). Similar process occurred at ISEMSI, where according to study examined intragroup communication, one of the crewmembers was excluded from communication (Bergan, Sandal, Warncke, Ursin, & Ragnar, 1993; Sandal, 2001). Subgrouping was observed in other experiments too, namely SFINCSS (Gushin, Pustynnikova, & Smirnova, 2001; Inoue et al., 2004), Mars 105 (Srb, Bahbouh, & Sýkora, 2012; Vinokhodova et al., 2012) and Mars 500 (Bahbouh et al., 2015a).

If a team is consisted by members talking different native language (SFINCSS, Mars 105, and Mars 500), subgroups are more likely formed according to native languages (subjects tends to communicate more with crewmembers with same native language). In case that no other subject has the same native language, such person tends to speak with crewmates that are also using foreign language (Srb et al., 2012). This phenomenon could be considered as a communicational analogy to an in-group, out-group effect (Tajfel, 1970). It can be caused either by different nationalities or cultural differences (Bahbouh & Děchtěrenko, 2014; Bahbouh, Sněhotová, Děchtěrenko, & Sýkora, 2015b). Knowledge of Russian and/or English is usually required in space research projects (Urbina & Charles, 2014).

4.2 Problematic relationship between crew and mission control center

In response to Štola-88, the importance of good relationship between the crew and mission control center (MCC) was pointed out. Sýkora highlighted that mission control center should be considered as a part of a crew. He came up with the Theory of lateral communication channel. This theory refers to the function of communication among the crew (or crews) and MCC. Two channels of a space mission communication can be distinguished. The main communication channel includes official information. Lateral one stays for unofficial or private information. Both, formal as well as informal communication channels are equally important (Sýkora, 1989, 1996; Sýkora et al., 2010).

Few studies focused on relationship between a crew and MCC. Communication among crew and the crew and control center was included in sociomapping of studies of Mars 105 and Mars 500 (Bahbouh, 2012; Lačev, Srb, et al., 2012; Srb et al., 2012). Tension between ground control center and crew was reported at Skylab, Salyut, Mir, and STS and can mean a symptom of real problems on board (Ursin et al., 1992) and lead to displacement of tension and dysphoria to mission control (Kanas, 1998; Kanas, Salnitskiy, Boyd, et al., 2007; Kanas et al., 1996; Sandal et al., 1996; Vaernes, 1996). Additionally, also recent results from Lunar Expedition 0 highlighted the importance of trust and good cooperation between crew and MCC (Davidová, 2017; Kołodziejczyk, Ambroszkiewicz, et al., 2017), similarly as recent EVA simulations (Harasymczuk et al., 2017).

4.3 High autonomy of a crew

High crew's autonomy represents one of the psychosocial challenges regarding long-duration spaceflights. Considering mission to Mars time delay may reach up to 24 minutes one way which will make communication very difficult. Astronauts must be trained in decision making, MCC might not be able to help in urgent situations (Drake, 2009; Ursin et al., 1992).

Several studies focused on communication between crew and MCC to examine simulation of high autonomy. Study of Mars 105 brought the finding that high autonomy with less opportunity to communicate with MCC and less external stimulation may facilitate „closing of communication channel" (Gushin et al., 2012). This term was defined as tendency of crewmembers to avoid a share of feelings with outsiders (Gushin et al., 1997). Shved with colleagues studied communication between astronauts and MCC to assess the impact of autonomy in Mars 500 study (Shved et al., 2013). This isolation experiment simulating Mars mission was also the first experiment that simulated an increasing communication delay between crew and MCC. The delay reached 12 minutes at the 350th day of the project. Moreover, MCC stopped communication with astronaut crew completely at the period from

320th to 327th day of the mission (Ushakov et al., 2014). When communication between crew and MCC was re-established, crew not only did not compensate the lack of communication with MCC, astronauts even talked on reduced level with MCC despite they felt a gradually increasing need for psychological support from mission control, especially for feedback and encouragement relating their tasks (Shved et al., 2013).

4.4 Declines in motivation of individuals

Motivation of candidates is assessed already during astronaut selection (Cazes, Rosnet, Bachelard, Le Scanff, & Rivolier, 1996). Motivation of astronauts is major psychosocial factor affecting crews on long-term space journeys (Kanas, 1998). Task motivation seemed to be an important characteristic for compatibility between crewmembers. Motivation has also implications for composition, training, and support of crews for extended spaceflights (Sandal et al., 1995).

The importance of motivation and perceived meaningfulness of assigned tasks was mentioned already in response to Štola-88 (Sýkora, 1989), or later on as a part of study of astronauts' values over the period of Mars 500 experiment (Sandal & Bye, 2015). Similar results were described from four months long analogue Mars mission in Devon Island. This study pointed out that crewmembers must perceive their work genuinely important. They cannot feel like they are taking part in *only* a simulation. Crewmembers are willing to spend significant amount of time on human factor related studies (filling questionnaires etc.) if they perceive that the studies could produce meaningful results. Different kind of motivation also appears by a desire to gain a better understanding of one's own traits, psychophysiological changes and behavior over time (Binsted et al., 2010). Such findings are highly important especially for planning future space mission simulations and analogue studies.

4.5 Dissatisfaction with diet

The issue of food and nutrition has already been actual for many years. It is not surprising that diet represent a stressor for teams in extreme environment (Sandal & Bye, 2015; Sandal, Bye, & van de Vijver, 2011). Astronauts have a very restricted supply of fresh food, the consistency is different than normally, and the typical smell is absent (Ushakov et al., 2015). Food must remain edible throughout the voyage, and it also needs to provide all the nutrients required to avoid vitamin-deficiency diseases. Considering a space mission, there are limitations to weight and volume, and microgravity conditions. There is also limited storage space and no refrigeration possibilities. Thus. food must be proceed through special procedures for preparation, packaging, and storing (George, Casaburri, & Gardner, 1999). The ISS food system provides a menu with a cycle that is repeated after 6 to 10 days. Approximately half of the food items are supplied by the United States and the second half by Russia (George et al., 1999; Perchonok & Bourland, 2002). Teams staying in other than space conditions (e.g. polar expeditions) have more possibilities of food storage, they can have for example frozen food (Stuster, 1986; Wood et al., 1999), however, the sameness of the food is stressful too (Stuster, 2000).

Already Štola-88 experiment at 1988 focused on relationships between crewmembers and animals and plants as a potential source of fresh food during long term missions (especially mission to Mars). However, results indicated that after a period when subjects were taking care of animal, they will have significant difficulties to kill those animals and eat them. These animals became to be rather pets than source of a food (from personal interviews with Dr. Sýkora, head of the Štola-88 project).

The project Biosphere 2 refers to serious problems caused by hunger of the crewmembers that had an overlap to interpersonal difficulties. Subjects had to guard the food they had, because even stealing occurred (MacCallum & Poynter, 1995; Maccallum, Poynter, & Bearden, 2004; Nelson et al., 2015; Walford et al., 1992).

Dissatisfaction with diet was observed in Mars 105 experiment where, in first part of the mission, the crew felt hungry. According to Mars 105 analogue astronauts, the diet insufficiencies had a negative impact on their interactions and led them to feel stress (Sandal et al., 2011). Moreover, progressive weight loss was also recorded in this period (Strollo et al., 2014). Complications with meals were found in Mars 500. crewmembers mentioned that several products were found spoiled after opening, although thanks to some food redundancy no troubles occurred (Urbina & Charles, 2014). In contrary, crew simulating four months of Mars mission in a FMARS habitat, had to prepare their food by themselves. Crew’s satisfaction with diet and effort they put into meals preparation was surprisingly high and had positive impact to social interactions (Binsted et al., 2010).

4.6 Stress and adjustment

Stress can be defined as any change in an organism produced by a stressor while stressor is a condition affecting organism (Kanas & Fedderson, 1971). To define stressors typical for certain situations is the first step necessary, if designing preventive provisions or countermeasure strategies is necessary. Stressors acting on humans during long-term crewed spaceflight can be divided into 4 categories: physical external to the human organism, physical internal (agents acting directly on the sensory system), social-interpersonal, and psychological (Geuna, Brunelli, & Perino, 1995; Kanas & Fedderson, 1971).

It is important to point out that for extreme environments physical factors might act as psychological stressors and thus have negative impact to individual performance as well as interfere with team performance (Lugg & Shepanek, 1999; Muller et al., 1995; Zimmer et al., 2013). Additionally, Zimmer with colleagues in her overview (2013) mentions that mood and cognition alteration problems are still reported from polar expeditions despite significant investments in the research station structure even though studies indicating neutral and even positive effect of long term stay at Antarctica on cognitive performance (John Paul, Mandal, Ramachandran, & Panwar, 2010). The frequently mentioned symptoms regarding teams staying in polar areas are: cognitive impairment, depression and low moods, anxiety, and irritability (Palinkas & Suedfeld, 2008; Zimmer et al., 2013). Impaired cognition (reduced accuracy and increased response time for cognitive tasks of memory, vigilance, attention, and reasoning), susceptibility to suggestion, intellectual inertia, spontaneous fugue states (known as Antarctic stare), depressed mood, anger and irritability, anxiety, interpersonal tension and conflicts (intragroup as well as towards externals) (Palinkas & Suedfeld, 2008).

Stressors occurring as a part of polar mission can be found in many ways similar as those associated with spaceflights. Similarly, as for space journeys, isolated and confined environment was mentioned as one of the most significant stressors in 84.0% of the publications regarding Antarctica stays (Zimmer et al., 2013). Another frequently mentioned problem for both, polar as well as space missions represent sleep disturbances (Kanas & Fedderson, 1971; Kanas & Manzey, 2008; Kass, Kass, & Samaltedinov, 1995; Manzey, 2004; Palinkas et al., 2000; Palinkas & Suedfeld, 2008; Strollo et al., 2014; Vaernes, Bergan, et al., 1993; Zimmer et al., 2013).

There are also specifics stressors connected to the long duration space missions: constant risk of danger, isolation and confinement, monotony, very restricted contact with close people, cultural issues, personality conflicts, crew heterogeneity, high workload (e.g., spacewalks, emergencies), crew size etc. (Kanas, 2014, 2015; Kanas & Manzey, 2008). Specific for space environment are also hypo-stimulation and sensory deprivation. Ushakov et al. (2014) refers to relationship between crewmembers of Mars 500 and plants. Plants became to be important as a compensation of hypo-stimulation and sensory deprivation, they had to face during their 520 days long isolation in NEK facility. The amount of time spent in the greenhouse by astronauts with plants was influenced by sensory deprivation, aesthetic needs, and environmental monotony. The analogue astronauts of this projects referred also to the perceived lack of acknowledgment of the received messages from MCC as one of the most relevant (even though unintended) stressors. They had to wait for long until their messages were answered by the ground control or were not answered at all which could give them the impression of a lack of interest from the researchers and certainly negatively affects the work morale of the crew (Urbina & Charles, 2014).

An interplanetary mission bears additional stressors: effects of long-term microgravity and high radiation, of extreme isolation and loneliness, of dependency on machines and local resources, time effect (knowledge about how much time remains), limited social contacts and novelty, the lack of support due to communication delays, an increase in autonomy, using a common language, intercultural issues, or family problems at home (Kanas, 2014, p. 74). Factor specific for a long-term spaceflight is the workload that fluctuates throughout the period of a mission. Certain stages of the journey expose the astronauts to a high workload, while others are connected with monotony and boredom (Kanas, 2015; Kanas & Manzey, 2008; Peldszus, Dalke, Pretlove, & Welch, 2014). New ongoing studies on the subjective time perception in humans, and alterations of it, aim to improve the working quality in isolated areas (Kołodziejczyk, Harasymczuk, Girardin, & Davidová, 2017). The gained knowledge, due to the psychosocial implications, can be of importance for future space missions.

Another issue connected to a journey to Mars, is the *Earth-out-of-view* phenomenon. Astronauts sent to Mars will be the first human beings who will for long period lose a direct visual link to the Earth due to the distance of 0.4 to 2.4 Astronomical Unit[2] between Earth and Mars. Human responses to this phenomenon are not known yet. No one has ever been in a situation where Earth, and all the associated aspects has been reduced to insignificance in the sky. Nevertheless, it seems to be obvious that it will psychologically affect astronauts. It is suggested by many reports from astronauts reporting the psychological importance of looking to the Earth from space. *Earth-out-of-view* phenomenon will probably deepen the feelings of

[2] 1 Astronomical Unit (AU) = 150 000 000 km

isolation and autonomy. Obviously this phenomenon cannot be studied before the first crewed interplanetary mission will be conducted (Horneck et al., 2006; Kanas & Manzey, 2008; Manzey, 2004).

It would be very beneficial to know in advance in what stage of a mission, intragroup conflict and difficulties are more likely to occur. Several attempts to identify the stages of adaptation and a team's development, considering teams in extreme condition, have been registered. However, the general development of teams over time or stages of individual adaptation and stress coping are not clearly defined yet for teams in extreme conditions.

Typical approach to this field offers Tuckman. He reviewed articles dealing with stages of group development over time and identified 4 general stages: forming, storming, norming, performing (Tuckman, 1965) and later added fifth: adjourning (Tuckman & Jensen, 1977). There are also authors who target to describe phases of adjustment to the specific conditions of extreme environments, and team's development over the period of isolation and confinement, albeit the findings differ across studies a lot.

Already Sýkora (1989) noticed changes in work efficiency in the end of the spaceflight simulation in response to Štola-88 isolation study. Similarly, the final part of a simulated space mission, Mars 105 was considered as a critical time period when deterioration of psychosocial crew´s dynamics - decline in cooperation, team's atmosphere and overall crew's performance was recorded (Bahbouh, 2012; Lačev, Srb, et al., 2012) as well as decreased score of positive emotions (Nicolas, Sandal, Weiss, & Yusupova, 2013). Experiments HUBES and ECOPSY revealed gradual decrease of communication followed by increasing tension due to the separation into subgroups of two crewmembers and one solitaire (Bahbouh, 1996, 2012; Gushin et al., 1998).

Four stages of the team dynamics were distinguished from sociomapping study (Lačev, Srb, et al., 2012; Lačev, Sýkora, et al., 2012) conducted as part of Mars 105 isolation experiment: initial harmonization, stabilization, repetitious harmonization followed by a *crisis*, and final harmonization. These phases were identified based on sociomaps of communication preferences. Most of the psychosocial changes occurred during first three data collections – the phase of *initial harmonization.* This phase was followed by *stabilization* (between 3rd and 4th data collection) characterized by no demands for changes in communication frequency. Next phase – *repeated harmonization* (between 4th and 5th data collection) was described by the increasing requirement of communication changes and need of support. *Crisis* phase (6th data collection) was accompanied by decline in parameters as are cooperation and team´s performance and the difference between optimal and expected communication frequency reached its peak this period. The last phase - *final harmonization* was characterized by no demands on communication changes (Lačev, Srb, et al., 2012; Lačev, Sýkora, et al., 2012). The assumption of similar development in later experiment Mars 500 was proved only partially (Lačev, Sýkora, et al., 2012).

The results of investigations regarding teams staying in Antarctica often refer to 3rd quarter phenomenon (Bechtel & Berning, 1991b; Palinkas et al., 2000) although this phenomenon was mostly not proved for space related studies (Basner et al., 2014; Kanas, 2014; Kanas, Salnitskiy, Ritsher, et al., 2007; Palinkas, 2001; Šolcová et al., 2013; Wu & Wang, 2015). Data of Mars 105 studies show negative psychosocial changes. Deterioration of psychosocial components such as cooperation, atmosphere within the team, and overall crew's performance (Bahbouh, 2012; Lačev, Srb, et al., 2012) as well as decreased score of positive emotions (Nicolas et al., 2013) was observed in last part of the Mars 105 study.

Some scientific papers address mid period of a mission to be critical, for example based on ethological studies of polar expeditioners and teams simulating space missions (Tafforin, 1993, 2005, 2013). Gushin et al. mentioned, negative psychological symptoms appear after 14 to 16 days if mission is 1 month long. In case of duration of 3 months, these symptoms after 45 days (Gushin, Kholin, & Ivanovsky, 1993). Unfortunately, there is no clear explanation of obtaining these findings in the text.

Cyclic development in course of long-duration spaceflight has also been proposed (Eskov, 2011) and was indicated in Mars 500 (Tafforin, 2013).

Gradual decrease of communication, that was accompanied by increased tension, was observed in the end period of two isolation experiments: HUBES and ECOPSY. Both of these experiments were attended by three-membered crew that gradually split into a dyad and solitaire (Bahbouh, 1996, 2012; Gushin et al., 1998).

Suedfeld (2010) identified five phases of isolation that considers relevant to Mars mission: acute, intermediate, long-duration, final and recovery. Acute phase was related to the very busy first part of adjusting to the novel situation. Following intermediate phase was characterized by fatigue, decreasing motivation, and psychosomatic and psychological problems. Long-duration phase was described to be tending to more drastic negative changes in motivation, mood, and performance. Final phase was associated with euphoria and hyperactivity as the mission draws to its end. Last recovery phase regarding the period of time after the end of an expedition when one adjusts back to the original conditions.

5. Conflict prevention

This chapter aims to search for prevention of intragroup conflicts. Some of the possibilities that could be applied when designing strategies for preventive provisions and countermeasures of certain psychosocial risks and issues, will be mentioned.

5.1 Salutogenesis

It is intuitive to expect that undergoing psychological duress can have psychological repercussions with pathogenic consequences resulting in various psychological symptoms (Leach, 2016). However, there are not only torturous aspects when undergoing all the difficulties and stress connected with cohabitation in extreme environment. Specialists designing psychosocial support should also count with naturally occurring protective factors.

Psychologists have already started to import the concepts of positive psychology in the space program recently and to consider salutogenesis - the benefits of participation, including the self-enhancing aspects of stressful experiences (Suedfeld, 2005). Space salutogenesis represents the phenomenon of personal growth and improved of psychological functioning after a spaceflight. These positive effects on mental health may help protect an onboard team from the psychological stress inherent in such risk missions (Ihle, Ritsher, & Kanas, 2006; Kanas & Manzey, 2008; Šolcová et al., 2013).

Kanas with colleagues studied positive effects of spaceflight to individual growth and developed a Positive Effects of Being in Space (PEBS) questionnaire. In their empirical study assessing 39 astronauts, every respondent reported a positive reaction to being in space. Changes in both attitudes and behaviors were mentioned by respondents. The strongest related experience referred to the Earth's beauty and fragility (Ihle et al., 2006).

The beauty of Earth is frequently mentioned strong positive experience from astronauts from ISS missions. Out of almost 200,000 photographs taken on eight ISS expeditions, 84,5% percent were initiated from crews. Photography taking was considered to have a potential salutogenic effect on astronauts on long-duration missions (Robinson et al., 2011).

Palinkas and Suedfeld who reviewed results from polar expeditions found many salutogenic after effects, e.g. affiliation, intimacy with fellow crew members, sense of personal achievement, cooperativeness, striving toward important goals, courage, resoluteness, indomitability, excitement, curiosity, increased self-esteem and self-efficacy, hardiness, resiliency, improved health, group solidarity, cohesiveness, reduced conformity, reflection, contemplation, increased sense of humanity etc. (Palinkas & Suedfeld, 2008).

5.2 The selection and composition of a team

Appropriate team selection is crucial for overall good team functioning and prevention of conflicts. It is hard to define what is the best way how to select team members that would be well performing in extreme conditions although considering space missions, crew selection is just the very beginning, followed by long period of training (Urbina & Charles, 2014; Vaernes, 1996). Team's composition and processes such as cooperation or team's cohesion play important role already in crew selection and training period (Sandal, 2001).

Psychology plays an important role in human space exploration already in the process of astronaut selection. Astronauts must be very properly selected to ensure a good performance and overall success of a mission. Group-assessment of team's compatibility prior to the experiment can be marked as one of the reasons why two experiments – ISEMSI and EXEMSI expressed different team-work qualities (Manzey as cited in Sandal, 1998). The crew of EXEMSI, in comparison to ISEMSI, expressed significantly better team cohesion and communicational relations (Sandal, 2001). Psychological compatibility assessment in pre-mission phase is traditionally applied in Russian projects (Cheetham, 1981). Thorough group assessment was carried out in the training phase of Mars 500 project. In order to test crew compatibility, the crew has to undergo a survival training in the Russian forest (Urbina & Charles, 2014; Ushakov et al., 2015).

Palinkas and Suedfeld (2008) were looking for the ideal person for polar expeditions. Based on many studies, the defined this characteristics for long expeditions are: older than 30 years, emotionally stable, few symptoms of depression, low neuroticism, introverted but socially adept, satisfied with social support, not greatly extraverted or assertive, no great need for social interaction, low demands for social support, sensitive to needs of others, desire for optimistic friends, high tolerance of little mental stimulation, does not become bored easily, high tolerance to lack of achievement, low need of order. While for short duration mission there is significantly less requirements: high motivation to achieve, high sense of adventure, low susceptibility to anxiety (Palinkas & Suedfeld, 2008, p. 160).

Isolated polar groups are vulnerable, the ability to resist infections may be influenced by anxiety, depression, or other environmental stressors. All Antarctic groups can express unusual if not bizarre behavior. Such findings can serve as lessons learned for space mission planning, despite relatively low number of reported psychological/psychiatric problems in Antarctica. What cause difficulty in Antarctica, in space could be disastrous, even fatal (Lugg & Shepanek, 1999).

Space crew selection is made in several steps including medical and psychological questionnaires, prove of candidates' motivation, assessment of psychological compatibility of the members, their self-control and stress tolerance. Additionally, the structural and functional characteristics, the hierarchical structure, and distribution of functional roles of a small group, and group cohesion are taken into account (Urbina & Charles, 2014; Vaernes, 1996; Vinokhodova et al., 2012).

5.2.1 Number of members of a crew for long-term spaceflight

The number of crewmembers to be sent to Mars has been discussed already in the earliest era of Mars mission. In 1948, 60 years prior to the current study, in the time when the knowledge of Mars was much more limited, von Braun with a group of scientists and engineers put together a plan that would send 70 people to Mars (Drake, 2009; Von Braun, 1953). As science and technology has advanced, the number of crew members needed for a successful first Mars mission has steadily decreased (Drake, 2009).

The issue of the number of crewmembers to be sent to Mars represent extremely important topic because of many reasons that are crucial for mission planning, for example: food and water supply, the size of the habitats, space transportation system, etc. This all will, also have a direct relationship to the cost of the mission. On the other hand, the size of the crew would be probably inversely proportional to the amount of new technology that must be developed to allow all tasks to be performed. Typically, it is assumed that a crew size of fewer than 10 astronauts is reasonable even though there is still not a clear answer. Final decision of this topic will depend on the specific objectives that are set for the crew (Drake, 2009). Review from 1992 mentions that most of the literature considers crew of 4-6 astronauts (Ursin et al., 1992). The number of six seems to be the most discussed. Six astronauts also attended simulation projects Mars 105 and Mars 500 (Basner et al., 2014; ESA, 2011; IMBP, n.d.; Shved et al., 2014; Spring, 2010) in spite of Kanas' findings, who mentioned that odd numbered crew (larger than three crewmembers) can more easily achieve consensus than even-numbered crews (Kanas, 2015; Kanas & Fedderson, 1971; Kanas & Manzey, 2008). Orion spacecraft, designed by NASA for journey to Mars, is designed for a crew of 2-6 astronauts while mostly mentioned number of astronauts to be sent to Mars is four (NASA, n.d.-a, n.d.-d). Additionally, the number of 6 is not rare either when considering polar expeditions e.g. (Wood et al., 1999).

5.2.2 Mixed-gender crew

There is no clear consensus whether to allow a mixed-gender crew or male only crew for long-term space mission. Russian researchers are usually against women in crew (Oberg, 2005), their projects are mostly attended only by male members in terms of space missions (Goel et al., 2014) as well as simulations (isolation studies) such as: HUBES (Gushin et al., 1997), ECOPSY (Gushin et al., 1998), Mars 105 (Gemignani et al., 2014) and Mars 500 (ESA, 2011; Spring, 2010). Issues that occurred during SFINCSS-99, the fight between Russian subjects and an attempt to kiss a female crewmate, and their consequences (Hermida, 2006; Inoue et al., 2004) probably deepened this attitude even though the perspectives on these issues differs a lot (Gray, 2000; Hermida, 2006; Inoue et al., 2004; Trickey, 2000). The outcome and consequences of this experiment led Russians to select to further isolation experiments (Mars 105 and Mars 500) men only (Oberg, 2005; Ushakov et al., 2015) despite current development indicate that this attitude may change soon. IMBP has already conducted a study of all-women crew and currently plans new isolation projects that counts with women in crew (IMBP, 2017; Orlov et al., 2016). Other authors offer different approach. They recommended to accept married couples to a crew (Kanas, 1998; Ursin et al., 1992), however there are no experimental space studies on this topic.

Results of Štola-88 emphasized that a woman may positively influence team under stressful conditions, specifically "mother-like type" of women is recommended as a highly suitable element of a crew for long duration spaceflight according to assumption that the participation of females increases diversity, thus also stability of a crew under conditions of long-term space flight (Sýkora, Šolcová, Dvořák, Polánková, & Tomeček, 1996). The presence of a woman serves as a stress relieving factor, that mitigates the degree of undesirable competition among men and decrease potential intragroup tensions. Woman also tolerate a chronic stress better (Sýkora et al., 2010, 1996). This knowledge corresponds to the finding that mixed-gendered teams outperform mono-gendered teams because presence of women in groups “normalize” male functioning and promote more active cope behavior and earlier conflict resolution (Aries, 1976; Baird, 1976).

Aries focused on the effects of group´s sex composition in interaction styles. Men decrease their aggressive and competitive behavior if a woman is present. Themes typical for men such as aggression, competition, victimization, and practical joking were no longer frequent if mixed gender team was assembled. Male also took on a more interpersonal orientation with women presented. The presence of women changed the all-male style of interacting by pushing males to develop more personal orientation with greater self-revelation. In contrary, female’s interactional styles remained more or less same in both all-female and mixed gender groups (Aries, 1976).

All-female expedition teams exhibited highly effective patterns of work and communication with low competitiveness. All-female expedition teams were more sensitive in emotional concerns although in other aspects were similar to male or mixed gender teams in (Kahn & Leon, 1994).

However, only few women were in space in comparison to men (Goel et al., 2014). As of the end of year 2013, the overall number of females in space was less than 11% of the total (Clément & Bukley, 2014), and 15% of the U.S. astronauts (Ronca et al., 2014).

II. EMPIRICAL PART

6. Research proposal

Intra-crew conflicts and dynamics over the course of a simulated Mars mission.

As pointed out in the theoretical part, cohabitation in extreme conditions means many challenges and risks for humans. Monitoring of psychosocial aspects and psychological support needs to be provided. Humans' behavior is relatively unpredictable, driven by various needs and motivations. Any failure may be disastrous, even fatal (Clément & Bukley, 2014; Horneck et al., 2003; Horneck & Comet, 2006; Lugg & Shepanek, 1999). To prevent from potential conflicts and failures, adequate monitoring of psychosocial aspects of a team is necessary. Such investigation needs to consider team dynamics and team's development over time. Space exploration still lacks enough relevant studies relating such aspects. Furthermore, generalization of findings from previously conducted investigations is very difficult thus many basic questions relating human factor in space remain unanswered (Davidová, 2016b). A comprehensive study based on psychosocial aspects of a crew is needed in order to provide relevant findings and lessons learned for future research.

6.1 Objectives, definitions, and research questions

This research project aims to capture the crew's dynamics during the course of the isolation. The results are also going to provide deep insight into the intra-team processes including team structure, relations among crewmembers, and identification of the phases associated to intragroup conflicts as well as their causes. Research designs, regarding this area, applied in the past research projects are disunited in methods as well as in their findings. Thus, this research project is explorative in terms of methods. It requires a new, quality, sustainable, and complex research design that could be repeatedly applied in various experiments for possible capture of recurring phenomena and generalization of findings.

Before moving to the methods, it is needed to define major terms of this proposal. The first of them is *team dynamics*. It is very complex, hence also difficult to define (Bußmann, 2014). It may be defined as the influential actions, processes, and changes that occur within groups (Forsyth, 2014). For this work team dynamics describes the relations within a team and their development in time. These aspects are closely associated to the team processes such as mutual communication and cooperation.

The second important term is an *intragroup conflict*, defined in first section of this work as a complex phenomenon caused by a discrepancy at the team-level area, that is perceived by a member (or members) of the team, and it negatively psychologically influences a member (or members) of the team with various level of impact on the team dynamics, mutual interactions, and overall team processes.

There are several aspects that can be studied out of this research design. According to the focus of this research project and the objectives stated above, the research questions (RQ) were formulated:

RQ1 How does the results gained from subjective and objective assessment differs?

RQ2 What factors contribute to the intragroup conflicts and, in contrary, what factors are considered protective?

RQ3 How will the team structure be changing over time?

RQ4 What are the impacts of having mixed-gendered crew to the interactions among the subjects?

RQ5 What impact does the relationship between the crew and MCC have on the crew dynamics? What factors are conducive to the good relationship with MCC and what factors worsen this relationship?

6.2 Methods

The first the subjects and setting are going to be introduced. Six analogue astronauts (4 men and 2 women) will undergo 60 days long simulation of mission to Mars in M.A.R.S. habitat in Poland, see the habitat design in *fig.1*. The mission will be analogous to mission to Mars in all aspects that can be simulated on Earth. Crew will be supported by MCC and will work according to procedures and day schedules.

The selection criteria for analogue astronauts will include: age between 30 and 55 years which is the age scope of most of the ISS astronauts (Goel et al., 2014), good physical, psychiatric and psychological health examined by certified experts, no food constraints, appropriate education in certain scientific fields (based on scientific experiments that will be conducted as a part of the mission). The selected individuals will be trained for the mission. Moreover, in the pre-experimental phase the crew as well as back-up astronauts will attend a short workshop – 2 days long simulation that will serve as a final test of team compatibility and overall readiness for the experiment as well as pre-experimental data collection.

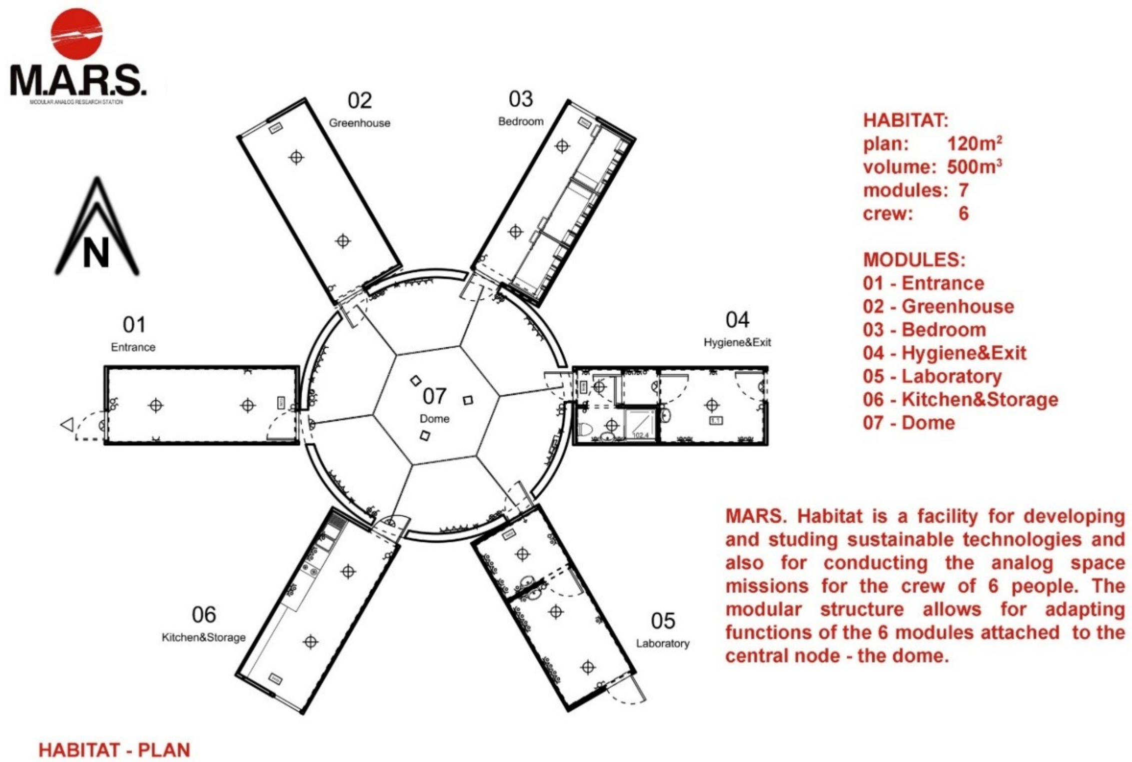

Figure 1: Scheme of M.A.R.S. habitat, retrieved from M.A.R.S. internal documents.

Since the subjects and setting are set, the applied methods can be described. The proposed study is qualitatively oriented, based on various methods combining subjective and objective assessments. Thereby, the triangulation of methods as well as of data will be achieved. The applied methods are: sociomapping, observations, and interviews. As already mentioned, the main research aspect is the team dynamics during the period of the simulated Mars mission with the focus on intragroup conflicts. The summary of applied methods and researched aspects is described in *tab. 1*.

Method	Specification	Researched aspects
Sociomapping	Subjective assessment by astronauts via questionnaire, most of the questions based on 7-point scale	*Intra-team processes:* intragroup communication and cooperation, mutual trust, interpersonal preferences, perceived crew's performance *Inter-team:* relationship between crewmembers and MCC *Individual:* perceived discomforts
Focused and free observation	Objective assessment by observer placed in MCC	Physical distance and interactions among crewmembers, overall team functioning
Interviews	Analysis of interviews to provide detailed knowledge, explanation,	*Intra-team processes:* interaction among subjects, team's development over time *Inter-team:* relationship between crewmembers and MCC

	and validation of other data	*Individual:* perceived conflicts, difficulties, emotions, satisfaction, and challenges, aspects of mixed-gendered crew

Table 1: Researched methods, their specification, and researched aspects.

Sociomapping

Sociomapping is a sociodiagnostic method that enables to monitor the crew´s interactions. This method was already applied in space exploration several times, namely in experiments HUBES, ECOPSY, Mars 105, and Mars 500 e.g. (Bahbouh, 2012; Bahbouh et al., 2015b). Sociomapping method provides an analysis and dynamic visualization of psychosocial interactions among crewmembers. Continuous analysis of team's dynamics over the course of a mission allows capturing of long-term trends, and significant deviations from the stabilized patterns of mutual relations as well as early detection of quantity and quality changes of communication among individual crewmembers which is important in order to predict further development and a prevention of conflicts (Bahbouh, 2012; Bahbouh, Rozehnalová, & Sailerová, 2012; Bahbouh et al., 2015a; Lačev, Sýkora, et al., 2012).

A resulting sociomap is based on a sum of subjective mutual attitudes of all individual crewmembers towards each other. Distribution of individual points (people) in sociomaps stands for psychological proximity. Other pointer is height denoting by color and supported by contours. Height demonstrates the intensity of the event or effect given in certain question from questionnaire (e.g. the frequency of communication with a given person). Colors are ranged from red (highest intensity), through orange, yellow, green up to blue (lowest intensity) (Bahbouh, 1994; Rozehnalová, 2008).

Data will be collected via questionnaires and processed through the sociomapping software ("Sociomapping," n.d.) that enables instant visualization. The principle investigator (PI) of this research design is going to concurrently hold the position of mission psychologist in MCC to have an overview of all the processes regarding the mission. The questionnaires will be sent to the crewmembers every day. Additionally, representatives from the MCC, mainly capsule communicator (CapCom)[3] will be asked to fill the questionnaire in order to capture not only the interactions among crewmembers but also the bonds with MCC. This procedure takes approx. 5 minutes, preferably at evenings. All subjects will fill the questionnaire in approx. same time.

[3] The Capsule Communicator (CapCom) is the only person from MCC who can talk with the astronauts. He represents the main communication channel between astronaut crew and MCC.

Moreover, subjects will be asked to fill the questionnaire in the pre-experimental phase of the project, as a part of the training they undergo, also after the end of the mission (post-experimental phase).

Questionnaire (see *tab. 2*) is based on questions relating mutual communication and cooperation, crew's performance, interpersonal preferences, mutual trust, atmosphere within the crew, and perceived misunderstandings. Collected data will be analyzed immediately after receiving from all astronauts (and MCC representatives).

Aspect	Question	Answer	Who?
Communication frequency – current	How frequently do you communicate with the following people?	1-7	All astronauts, MCC (CapCom)
Communication frequency – desired	How often would you want to communicate with the following people?	1-7	All astronauts, MCC (CapCom)
Communication quality	Evaluate the quality of communication with the following people.	1-7	All astronauts, MCC (CapCom)
Cooperation -frequency	Evaluate the quality of cooperation with the following people?	1-7	All astronauts
Cooperation -quality	Evaluate the quality of cooperation with the following people?	1-7	All astronauts
Preference	Please, evaluate the following people according to your preference to interact with them in your free time.	1-7	All astronauts
Mutual trust	How much do you trust the following people/MCC?	1-7	All astronauts, MCC in general
Relationship between crew and MCC	How is the extent to which you are satisfied with the following people?	1-7	All astronauts, CapCom, FD, MP, PST representative*
Discomforts	If applicable, name the source(s) for the discomfort you are experience (e.g. noise, smell, food, sleeping problems, interpersonal conflict, etc.)	Open	All astronauts
Comments	You can add any comment or note (e.g. if something important happened, how do you feel etc.)	Open	All astronauts

*FD (flight director), MP (mission psychologist), PST (planning and scheduling team)

Table 2: Questionnaire.

Observation

Free and focused observation from Mission Control Centre (MCC) will be applied to gain a detailed insight to the crew's dynamics. Whole period of the mission will be video recorded so all details could be captured. Continual free observation will be conducted from MCC. Important findings will be constantly noted. This procedure will help to identify what questions would be valuable to ask individual subjects as a part of interviews. Moreover, all communication among individuals (except the communication strictly related to work) will be later literally overwritten and analyzed by **grounded theory**.

Grounded Theory was designed by sociologists Barney Glaser and Anselm Strauss in 1967 to open a space for the development of new, contextualized theories and originally developed who aimed to develop a method that would allow them to move from data to theory, so that new theories could emerge (Glaser, 2013; Goulding, 2002). The data for a Grounded Theory can come from various sources, e.g. interviews, observations, newspapers, letters, books, etc. (Corbin & Strauss, 1990). This method involves the progressive identification and integration of categories of meaning from collected data. It represents both the process of category identification and integration (as method) and its product (as theory) (Glaser, 2013). Grounded Theory was chosen in this case because in contrast to content analysis, where categories are defined before data analysis, categories in Grounded Theory emerge from the data. This is beneficial because no important aspects can be overlooked. Apart from that, triangulation of methods will be achieved and comparison with content analysis (applied for data analysis gained from interviews) will be possible.

Focused observation will assess the information about actual position and interaction of the astronauts. This procedure will be conducted in the periods of astronaut's free time repeatedly at any time when the positioning of individuals will be changed. The data will be coded according to the criteria described in *tab. 3*. Findings based on focused observation will serve as a material for comparison to results gained by self-assessment questionnaire applied as a part of sociomapping.

Code	Criteria
1	No interaction, physically distant
2	*Social distance* (360 cm - 120 cm), no or slight hints of interaction
3	*Social distance* (360 cm - 120 cm) with apparent interaction or *personal distance* with no interaction
4	*Personal distance* (120 cm - 45 cm) with neutral communication
5	*Personal distance* (120 cm - 45 cm) with friendly, personal communication
6	Close *personal*/far *intimate distance* (60 cm – 40 cm), personal communication
7	*Intimate distance* (less than 45 cm), communication, touch

All of the distance specification in the table were identified based on (Hall, 1982).

Table 3: Criteria for coding the data from focused observation

Interviews

Post-experimental interviews with all analog astronauts are going to be conducted soon after the mission is terminated and will take approximately 1 hour. The interview is going to be led as a discussion about astronauts' experience to capture details about difficult moments that occurred during the mission, interpersonal preferences (to assess subgrouping tendencies), and the situations considered as breaking points for the psychosocial team development. Additionally, sociomaps, obtained during the mission, are going to be presented to astronauts and discussed. The crew will be asked if they agree with the findings and asked for describing background and explanation of psychosocially significant moments of the mission. After that, semi-structured interview with each individual astronaut will be conducted. Questions that are going to be asked to each individual are described in *table 4*. Additional questions will be created in response to the information provided by a subject.

Question	**Target**
Could you, please, briefly describe your experience from the mission? – Anything that comes to your mind right now.	Overview of important moments for a subject
What kind of aspects were the most challenging for you? (e.g. interpersonal conflicts onboard, cooperation with the crew-mates, dissatisfaction with food, sleep disturbances etc.)	Identification of difficulties as potential causes of conflicts
What was the most challenging moments during the mission?	Identification of difficulties
Was there any conflicts within the crew?	Identification of intragroup conflicts
With whom did you interact most frequently during the mission?	Validation of other findings (mainly sociomapping)
How do you evaluate the leadership of crew commander?	Validation of other findings
How do you evaluate the support from MCC?	Validation of other findings
Did you perceive any subgrouping tendencies within the team?	Validation of other gained findings (sociomapping)
How do you evaluate cooperation with your crew-mates?	Validation of other gained findings (sociomapping)
What is your best experience from the mission?	Identification of protective factors
What factors do you think helped you to overcome difficult periods?	Identification of protective factors
Can you imagine the mission to be longer? How would you feel about?	Overall satisfaction
Is there anything else you would like to mention?	Capture of possible further aspects

Table 4: Questions for semi-structured interview with individual crew members.

Interviews will be taped and processed by **content analysis**. Content analysis is traditional method of social psychology (Ferjenčík, 2000; Janoušek, 1968, 1986) that have been applied in several space-related experiments e.g. (Gushin et al., 1997, 2012) The categories for analysis were defined in consideration to the research questions. They are described in *tab. 5*.

Category	Related research question (RQ)
Factors contributing to intragroup conflicts	RQ2
Factors considered protective from intragroup conflicts	RQ2
Interpersonal preferences	RQ3
Gender issues	RQ4
Relationship to MCC	RQ5

Table 5: Categories defined for content analysis.

6.3 Data analysis

Data gain from relational questions (related to individual crewmembers) of the questionnaire are going to be instantly proceed by Sociomapping software ("Sociomapping," n.d.) and visualize as sociomaps. The data of non-relational questions will be proceeded with and aid of computer software and visualized.

Focused observation is going to assess intragroup relations in the periods of astronauts' free time, the interactions are going to be noted and coded according to criteria as described in *tab. 3*. Then these data will be calculated (to reach same time frequency as sociomapping questionnaires) also visualized as sociomaps. It means one resulted sociomap per each days of isolation. Thus, subjective perception of individual preferences and objective observation of intra-team interactions can be compared and later discussed with crewmembers during the post-mission interview.

Free observation is going to provide overview of the team functioning. This knowledge is going to be used during the common interview. Moreover, all the intra-crew communication will be recorded. The communication strictly related to work is not going to be used. All the other verbal communication among individuals will be overwritten and analyzed by Grounded Theory. Next step involves the procedure of categorizing. Categorizing is designated to the grouping together instances that share central features or characteristics with one another. After that coding is going to be conducted. Coding is the process by which categories are identified. In the early stages, coding is largely descriptive. As coding is proceeding, the identification of higher-level categories that systematically integrates low-level categories into meaningful units, coming place. Category labels will be grounded in the data, ideally *in vivo* which means the words or phrases used by the researched subjects will be utilized. A written record of theory development throughout the process of data collection and analysis (known also as *memo writing*) will be maintained. It will involve writing definitions of categories. Concurrently, the strategies connected to grounded theory - comparative analysis, negative case analysis, theoretical sampling, and theoretical sensitivity will be involved. The process of analysis ends when theoretical saturation is achieved.

Interviews are going to be analysed by content analysis. Data from interviews will coded according to the categories described in *tab.5*. As a product of this procedure, interpretations supported by the frequencies of occurrences of researched categories will be created.

When the data are analyzed by every of the methods, there is a time to move to the comparison of findings from the different methods. Triangulation of methods (Heale & Forbes, 2013; Jick, 2015) is applied to assess the crew dynamics with the focus on intragroup conflicts. There are the methods and their main relations displayed in *figure 2.* Data from three methods – sociomapping, focused observation, and common interview are going to be compared in order to find out if the results regarding the team's dynamics (the aspects of interactions, the team's structure etc.) because both – the data gained from the questionnaire intended for sociomapping, as well as the data gained from focused observation, will be visualized as sociomaps. Common interview is added to this dyad because there will be the resulted sociomaps discussed with the analog astronauts. Another comparison may be made of the content analysis of the individual interviews and the results gained from the Grounded Theory of the intra-group communication. However, all of the methods applied in this research project studies the same aspects and can be integrated.

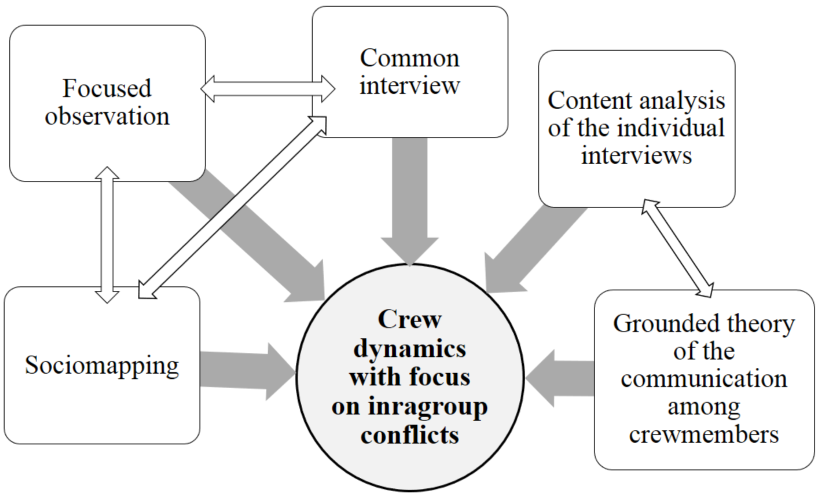

Figure 2: Chart of applied methods with their main relationships.

6.4 Further application

This study deals with the new research design that can be valuable for future psychosocial studies conducted as a part of space exploration. This research design (with minor differences) is planned to be applied as a part of two projects - Lunar Expedition 1, Poland Mars Analog Simulation (PMAS). Thus, all findings may be compared and recurring phenomena can be found. Psychosocial study on crew dynamics will be combined with continuous work as a mission psychologist in MCC. Data will be collected in all phases of the project: pre-experimental (training and preparation phase that is now in progress), experimental (2-weeks long analogue simulation) and the post-experimental period (Davidová, 2016a). Lunar Expedition 0, the test lunar mission, was conducted in summer 2016 and was using similar researched design as the one described as a part of this thesis (Davidová, 2017; Kołodziejczyk, Ambroszkiewicz, et al., 2017).

7. Discussion and conclusion

Intragroup conflicts of teams in extreme conditions deserve great attention. Unlike normal environment, where intragroup conflicts usually cause no more than difficulties and discomfort, such aspects may have fatal consequences if occur in extreme environment. This field combines many factors and variables. A lot of research regarding humans' cohabitation in isolation and confinement have already been done, answers and solutions are to be found. The present thesis aimed to map them through several perspectives to provide comprehensive understanding of this area.

First of these perspectives was devoted to describing the kinds of teams that were considered for this review. Past and current research of teams in extreme conditions was briefly noted to provide a base for following text sections. Following chapter deals with research methodology. The most frequent methods applied in past studies to assess intra-teams' conflicts were mentioned, namely: observation, content analysis of intragroup communication, analysis of logs and diaries, sociometry, PSPA test, sociomapping, self-report questionnaires. Each of these methods has some limitations.

Studies dealing with content analysis of intragroup communication traditionally lacks information regarding relations among crewmembers. Moreover, published findings (Gushin et al., 1997, 2012; Kimhi, 2011; Shved et al., 2013, 2014; Ushakov et al., 2012) are usually summarized for the whole team, thus potentially irregular distribution of communication among individual subjects cannot be recognized (Davidová, 2016a) and gained information is very limited, insufficient for conflict identification. Content analysis of logs and diaries would be well suitable as a supportive method. PSPA test is relatively complicated. Subjects are asked to choose assessment criteria to several times, by themselves, answering the question: What are the main features (traits) that allow you differentiate people from your close surrounding? Then they have to estimate the extent of psychological similarity between himself and his team-mates (Gushin & Vinokhodova, 2010). Such procedure may be tedious and too abstract for subjects. Furthermore, the resulting graphs are difficult to analyze. However, potential subgroups and perceived psychological distance can be recognized. Application of sociometry (Vinokhodova et al., 2012) would be suitable but it is needed to collect enough data if crew dynamics is going to be assessed. Sociomapping can provide good information about a crew's dynamics. The assessment execution of a research based on this method is relatively easy. However, some limitations may be found in this method too. Sociomapping may not be sensitive enough in case of more frequent data collection (Davidová, 2015), that is typical for shorter experiments (2 weeks or less).

There are several recommendations for methodology and methodics for future research:

- Combination of more methods would be beneficial to provide deeper insight to the problematics.
- Appropriate methods and suitable methodics should be applied (sufficient amount of data to collect, clear procedures, validation of findings etc.) to minimize potential bias, and to capture development of parameters over the period of stay in extreme conditions.
- Same research design should be applied repeatedly in various experiments to make a comparison possible.
- Further investigation of conflicts within teams in extreme conditions is needed.

After dealing with methodology, some of the specific factors affecting teams in extreme conditions that are likely to cause conflicts were introduced: disruption of team's cohesion, relationship between crew and mission control, high autonomy, declines in motivation of individuals, dissatisfaction with diet, and the aspects connected to the stress and adjustment. Some of these issues will be discussed.

There is still lack of research focused on the relationship between the crew and MCC, even despite its importance. Optimization of the relationship between the crew and ground control, could improve both inter as well as intragroup relations, which may prevent conflicts and tensions in the crew. Similarly, increased autonomy of astronauts on interplanetary missions, represent specific phenomenon that have not been studied much yet. Astronauts should be trained for that in pre-mission phase, not only to be able to solve all possible issues by themselves, but also to provide feedback to each other.

Other aspect of good work efficiency and overall flow of a mission is motivation. Candidates for a work in a team in extreme conditions must be assessed by individual traits that consider motivation as an important factor even though it is important to note that motivation and related aspects may differ in a course of isolation. Work capability can be distorted under severe isolation, the time needed for the execution of cognitive tasks and in the number of mistakes made increases, similarly the latency in decision making increases, and the motivation to work is reduced (Gushin et al., 1993). This knowledge needs to be taken in account when a mission is planned.

Food also represents a factor causing interpersonal difficulties. As described above, dissatisfaction with diet may have a significant impact on individual well-being and interpersonal relations including intragroup conflicts. On the other hand, it is known from ISS astronauts that re-supply that contain fresh food has positive psychological effect (Kanas, 2015). However, it is not possible to meet all needs of individual subjects when staying in extreme environment. Team members need to be highly resistant to different challenges, experienced, and well trained. It is inspiring to realize how it was back in the past. Historical voyages dealt with much more serious problems in terms of nutrition. Mariners suffered from medical issues (poor circulation, heart troubles, impaired digestion etc.) because their diet was low in fiber and certain vitamins[4] (Stuster, 2000).

When dealing with stressors connected to the long-term stay in extreme conditions, it is also important to consider people in a social context, with a connection to family and friends, which might not be present during long term missions. Families should be prepared in advance. They need to be ready for long-term separation and to be prepared for possible psychological changes of their family member. Providing support for families during the mission can positively contribute to the astronaut's concentration on the mission objectives by relieving them of considerations about feelings of responsibility and potential problems at home (Johnson, 2010; Kanas et al., 2009). There were also several attempts to identify stages of adjustment to the specific environment and to search for development of the team processes over the course of isolation. Nevertheless, the results are not consistent.

Next section of the text was focused on the prevention of intragroup conflicts through the focus on salutogenetic factors, selection of team members including group assessment, composition of a group. Several papers suggest higher risk of intragroup conflicts and tension due to the heterogeneity in culture and gender of team-mates of a team (Gushin et al., 2001; Kanas, 1998; Kanas & Manzey, 2008; Sandal, 2002; Vinokhodova et al., 2012) despite the opposite opinion is also possible to find (Binsted et al., 2010).

The effect of a woman in team and searching for suitable proportion of men and women in a small social group needs to be found in future studies. Psychosocial studies focused on mixed-gendered teams mostly support the positive effect of a woman to the group's functioning and performance e.g. (Sýkora, 1989; Sýkora et al., 1996; Værnes, 1996). Woman in group acts as a peacemaker, mitigates the degree of undesirable competition among men and decreases the

[4] As a response to this situation, onboard physician was trying to remedy the condition by encouraging the men to eat fresh penguin meat, although many of them found it unpalatable (Stuster, 2000).

intragroup tension (Aries, 1976; Binsted et al., 2010; Sýkora et al., 1996; Værnes, 1996). In contrary, mixed-gendered teams are connected to certain challenges (Hermida, 2006; Inoue et al., 2004; Oberg, 2005).

Finally, explorative research project on the crew dynamics with focus on intragroup conflicts of a team simulating a Mars mission was proposed with an aim to synthesize results gained from several methods, namely: sociomapping, focused observation, grounded theory of intra-crew communication, and content analysis of interviews in order to provide complex deep insight to the problematics of team dynamics and intragroup conflicts. This research design would be very beneficial to repeatedly realize because it can provide a significant knowledge not only about crew dynamics with possible identification of certain stages characteristic for cohabitation in extreme environment, but also for the methodological aspects of research in this area. - The proposed research design builds on several methods, so the triangulation of methods will assure high validity of findings. Moreover, the results from the subjective data can be compared with results gained from objective data. Also, mutual validation among methods is possible, even though in this stage, it is not possible to state that one of the methods provides more accurate findings than another. Hence, in this stage of the research it would be better to satisfy with a comparison of findings and identification of differences. An aim to identify the reasons of such variations can potentially be also conducted. The complex integration of the results from the aforementioned methods would propose independent research design with characters of qualitative metanalytic approach which is out of the scope of this work.

References

Altman, I., & Haythorn, W. W. (2015). Interpersonal Exchange in Isolation. *Sociometry*, *28*(4), 411–426. Retrieved from http://www.jstor.org/stable/2785992

Aries, E. (1976). Interaction Patterns and Themes of Male, Female, and Mixed Groups. *Small Group Research*, *7*(1), 7–18. http://doi.org/10.1177/104649647600700102

Bahbouh, R. (1994). *Sociomapování*. Prague: Gema Art.

Bahbouh, R. (1996). *Využití sociomapování u malých sociálních skupin*. Charles University. (Unpublished master's thesis).

Bahbouh, R. (2004). *Sociomapování*. (Unpublished doctoral dissertation). Charles University: Prague.

Bahbouh, R. (2012). *Sociomapping of Teams*. Prague: Dar Ibn Rushd & QED GROUP.

Bahbouh, R., & Děchtěrenko, F. (2014). Sociomapping of communication changes during simulations of flights to Mars. In R. Bahbouh & G. Lasker (Eds.), *Sociodiagnostics and sociomapping* (Vol. III, pp. 34–40). Canada: The International Institute for Advanced Studies in Systems Research and Cybernetics.

Bahbouh, R., Rozehnalová, E., & Sailerová, V. (2012). *New perspectives of psychodiagnostics*. Prague: QED GROUP.

Bahbouh, R., Sněhotová, J., Děchtěrenko, F., & Sýkora, J. (2015a). Sociomapování komunikace posádky v experimentu Mars-500. In I. Šolcová, V. Gushin, & I. Stuchlíková (Eds.), *Mars-500. Fakta a postřehy ze simulovaného letu na rudou planetu* (pp. 147–163). Prague: Academia. In Czech.

Bahbouh, R., Sněhotová, J., Děchtěrenko, F., & Sýkora, J. (2015b). Sociomapping the Communication of the Crew during the Mars 500 Experiment. In R. Bahbouh & G. Lasker (Eds.), *Sociodiagnostics and Sociomapping* (Vol. IV, pp. 1–14). Canada: The International Institute for Advanced Studies in Systems Research and Cybernetics.

Baird, J. E. (1976). Sex Differences in Group Communication: a Review of Relevant Research. *Quarterly Journal of Speech*, *62*(2), 179–192.

Bales, R. F., Cohen, S. P., & Williamson, S. A. (1979). *SYMLOG: A system for the multiple level observation of groups*. Free Press.

Barker, D. C. (2015). The Mars imperative: Species survival and inspiring a globalized culture. *Acta Astronautica*, *107*, 50–69. http://doi.org/10.1016/j.actaastro.2014.11.006

Basner, M., Dinges, D. F., Mollicone, D. J., Savelev, I., Ecker, A. J., Di Antonio, A., … Sutton, J. P. (2014). Psychological and behavioral changes during confinement in a 520-day simulated interplanetary mission to marsBasner, M., Dinges, D. F., Mollicone, D. J., Savelev, I., Ecker, A. J., Di Antonio, A., … Sutton, J. P. (2014). Psychological and behavioral chang. *PLoS ONE*, *9*(3), e93298. http://doi.org/10.1371/journal.pone.0093298

Becerra, M., & Gupta, A. K. (2003). Perceived trustworthiness within the organization: The moderating impact of communication frequency on trustor and trustee effects. *Organization Science*, *14*(1), 32–44.

Bechtel, R. B., & Berning, A. (1991a). The third-quarter phenomenon: Do people experience discomfort after stress has passed? In *From Antarctica to outer space* (pp. 261–265). http://doi.org/10.1007/978-1-4612-3012-0_24

Bechtel, R. B., & Berning, A. (1991b). The third-quarter phenomenon: Do people experience discomfort after stress has passed? In *From Antarctica to outer space* (pp. 261–265). New York: Springer.

Bell, S. T., Outland, N. B., Abben, D. R., & Brown, S. G. (2015). Critical Team Composition Issues for Long-Distance and Long-Duration Space Exploration: A Literature Review, an Operational Assessment, and Recommendations for Practice and Research. Retrieved August 24, 2015, from http://ston.jsc.nasa.gov/collections/TRS/_techrep/TM-2015-218568.pdf

Bennahum, D. S. (1997). An exclusive interview with Dan Goldin, NASA Director. Retrieved March 14, 2016, from http://memex.org/meme3-04.html

Bergan, T., Sandal, G. M., Warncke, M., Ursin, H., & Ragnar, V. (1993). Group functioning and commnication. *Advances in Space Biology and Medicine*, *3*, 59–80. http://doi.org/10.1016/S1569-2574(08)60097-0

Binsted, K., Kobrick, R. L., Griofa, M., Bishop, S., & Lapierre, J. (2010). Human factors research as part of a Mars exploration analogue mission on Devon Island. *Planetary and Space Science*, *58*(7–8), 994–1006. http://doi.org/10.1016/j.pss.2010.03.001

Bishop, L. S. (2011). From Earth Analogs to Space: Getting There from Here. In D. A. Vakoch

(Ed.), *Psychology of Space Exploration: contemporary research in historical perspective* (pp. 47–77). Washington DC: NASA.

Brannick, M. T., & Prince, C. (1997). An overview of team performance measurement. In M. T. Brannick, E. Salas, & C. Prince (Eds.), *Team performance assessment and measurement: Theory, methods, and applications* (pp. 3–16). Mahwan, New Jersey: Lawrence Erlbaum Associates.

Bußmann, U. (2014). *Group Dynamics: The Nature of Groups as well as Dynamics of Informal Groups and Dysfunctions*. Hamburg: Diplomica Verlag. Retrieved from http://ebookcentral.proquest.com/lib/cuni/detail.action?docID=1640385

Cazes, C., Rosnet, E., Bachelard, C., Le Scanff, C., & Rivolier, J. (1996). Group dynamics during the EXEMSI isolation study. Experimental Campaign for the European Manned Space Infrastructure. *Advances In Space Biology And Medicine*, *5*, 245–262. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=mnh&AN=8814802&site=ehost-live

Clément, G., & Bukley, A. P. (2014). Human space exploration – From surviving to performing. *Acta Astronautica*, *100*, 101–106. http://doi.org/10.1016/j.actaastro.2014.04.002

Coan, J. A., & Gottman, J. M. (2007). The Specific Affect Coding System (SPAFF). In J. A. Coan & J. J. B. Allen (Eds.), *Handbook of emotion elicitation and assessment* (pp. 267–285). Oxford University Press. http://doi.org/10.4324/9781410610843

Collet, J., & Vaernes, R. J. (1996). EXEMSI: The second European simulation of a long-duration manned space mission. Experimental Campaign for the European Manned Space Infrastructure. *Advances in Space Biology and Medicine*, *5*, 1–5. http://doi.org/https://doi.org/10.1016/S1569-2574(08)60050-7

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, *13*(1), 3–21. http://doi.org/10.1007/BF00988593

Davidová, L. (2015). Sociomapping of a Student Crew during a Simulation of a Flight to Mars. In R. Bahbouh & G. Lasker (Eds.), *Sociodiagnostics and Sociomapping* (Vol. IV, pp. 15–25). Canada: The International Institute for Advanced Studies in Systems Research and

Cybernetics.

Davidová, L. (2016a). Sociodiagnostic tools and their lookout in monitoring crews in prolonged isolations. In *67th International Astronautical Congress, Guadalajara, Mexico*.

Davidová, L. (2016b). Spaceflight simulations: Their findings and challenges. In R. Bahbouh & G. Lasker (Eds.), *Sociodiagnostics and Sociomapping* (Vol. V). Canada: The International Institute for Advanced Studies in Systems Research and Cybernetics.

Davidová, L. (2017). Astronaut interactions on the Moon: Lunar Expedition 0 as an Analogue. In *68th International Astronautical Congress, Adelaide, Australia*. - in press.

De Dreu, C. K. W., & Weingart, L. R. (2003). Task versus relationship conflict, team performance, and team member satisfaction: a meta-analysis. *The Journal of Applied Psychology*, *88*(4), 741–749. http://doi.org/10.5465/APBPP.2002.7516590

Dickinson, T. L., & McIntyre, R. M. (1997). A conceptual framework for teamwork measurement. In M. T. Brannick, E. Salas, & C. Prince (Eds.), *Team performance assessment and measurement: theory, methods and applications* (pp. 19–43). London: Lawrence Erlbaum Associates.

Dijkstra, M. T. M. (2006). *Workplace conflict and individual well-being*. Amsterdam: University of Amsterdam.

Drake, B. G. (2009). *Human exploration of Mars design reference architecture 5.0: Addendum*. NASA/SP–2009–566-ADD Human.

ESA. (2009). Mission accomplished 105-day Mars mission simulation ends in Moscow. Retrieved January 12, 2016, from http://www.esa.int/Our_Activities/Human_Spaceflight/Mars500/Mission_accomplished_105-day_Mars_mission_simulation_ends_in_Moscow

ESA. (2011). Mars 500 Isolation Study: Information Kit. Retrieved January 3, 2016, from http://esamultimedia.esa.int/docs/Mars500/Mars500_infokit_feb2011_web.pdf

Eskov, K. N. (2011). Evaluation of the efficiency of interpersonal interactions in a long-term isolation experiment. *Human Physiology*, *37*(7), 879–882. http://doi.org/10.1134/S0362119711070115

Ferjenčík, J. (2000). *Úvod do metodologie psychologického výzkumu: Jak zkoumat lidskou duši*. Praha: Portál.

Foing, B. (2016). Towards A Moon Village: Vision and Opportunities. *EGU General Assembly 2016*, *18*. Retrieved from http://meetingorganizer.copernicus.org/EGU2016/EGU2016-15695.pdf

Forsyth, D. R. (2014). *Group Dynamics*. Belmont, CA: Wadsworth Cengage Learning. http://doi.org/10.1146/annurev.ps.15.020164.002225

Gemignani, A., Piarulli, A., Menicucci, D., Laurino, M., Rota, G., Mastorci, F., … Bedini, R. (2014). How stressful are 105days of isolation? Sleep EEG patterns and tonic cortisol in healthy volunteers simulating manned flight to Mars. *International Journal of Psychophysiology*, *93*(2), 211–219. http://doi.org/10.1016/j.ijpsycho.2014.04.008

George, J. A., Casaburri, A. A., & Gardner, A. C. (1999). Space Food and Nutrition: An Educator's Guide With Activities in Science and Mathematics. Retrieved January 1, 2016, from http://er.jsc.nasa.gov/seh/Space_Food_and_Nutrition.pdf

Geuna, S., Brunelli, F., & Perino, M. A. (1995). Stressors, stress and stress consequences during long-duration manned space missions: a descriptive model. *Acta Astronautica*, *36*(6), 347–356. http://doi.org/10.1016/0094-5765(95)00115-8

Glaser, B. (2013). Grounded theory methodology. In *Introducing Qualitative Research in Psychology* (pp. 69–82). Maidenhead: Mcgraw-Hill Education.

Goel, N., Bale, T. L., Epperson, C. N., Kornstein, S. G., Leon, G. R., Palinkas, L. A., … Dinges, D. F. (2014). Effects of Sex and Gender on Adaptation to Space: Behavioral Health. *Journal of Women's Health*, *23*(11), 975–986. http://doi.org/10.1089/jwh.2014.4911

Gottman, J., & Silver, N. (2015). *The seven principles for making marriage work: A practical guide from the country's foremost relationship expert*. Harmony.

Goulding, C. (2002). *Grounded theory: A practical guide for management, business and market researchers*. London: SAGE Publications.

Gray, M. (2000, April 17). A space dream sours. *Maclean's*. Toronto. Retrieved from http://business.highbeam.com/4341/article-1G1-61432369/space-dream-sours

Gushin, V. I., Efimov, V. A., Smirnova, T. M., & Vinokhodova, A. G. (1996). [Dynamics of subjective perception of in-group interaction during long-term isolation and confinement]. *Aviakosmicheskaia I Ekologicheskaia Meditsina= Aerospace and Environmental Medicine*, *31*(4), 23–29.

Gushin, V. I., Efimov, V. A., Smirnova, T. M., Vinokhodova, A. G., & Kanas, N. A. (1998). Subject's perceptions of the crew interaction dynamics under prolonged isolation. *Aviation, Space, and Environmental Medicine*, *69*(6), 556–61. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9641401

Gushin, V. I., Kholin, S. F., & Ivanovsky, Y. R. (1993). Soviet psychological investigations of simulated isolation: Some results and prospects. *Advances in Space Biology and Medicine*, *3*, 5–14. http://doi.org/10.1016/S1569-2574(08)60093-3

Gushin, V. I., Pustynnikova, J. M., & Smirnova, T. M. (2001). Interrelations between the small isolated groups with homogeneous and heterogeneous composition. *Human Performance in Extreme Environments : The Journal of the Society for Human Performance in Extreme Environments*, *6*(1), 26–33. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-0035554447&partnerID=40&md5=1423638a709ea0d40221e7682e850e74

Gushin, V. I., Shved, D. M., Vinokhodova, A. G., Vasylieva, G. Y., Nitchiporuk, I., Ehmann, B., & Balazs, L. (2012). Some psychophysiological and behavioral aspects of adaptation to simulated autonomous Mission to Mars. *Acta Astronautica*, *70*, 52–57. http://doi.org/10.1016/j.actaastro.2011.07.020

Gushin, V. I., & Vinokhodova, A. G. (2010). PSPA - Test for the Study of Individual Values and Mutual Perception in Small Group. *Measuring Behavior*, 72.

Gushin, V. I., Zaprisa, N. S., Kolinitchenko, T. B., Efimov, V. A., Smirnova, T. M., Vinokhodova, A. G., & Kanas, N. A. (1997). Content analysis of the crew communication with external communicants under prolonged isolation. *Aviation Space and Environmental Medicine*. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9408558

Hackman, R. J. (1990). *Groups that work (and those that don't)*. San Francisco: Jossey-Bass. Retrieved from http://www.amazon.com/Groups-That-Work-Those-Dont/dp/1555421873/ref=sr_1_1?s=books&ie=UTF8&qid=1314379993&sr=1-1

Hall, E. T. (1982). *The Hidden Dimension*. New York City: Anchor Books.

Harasymczuk, M., Foing, B. H., Kołodziejczyk, A., Vos, H., Krainski, M., Davidová, L., … Casini, A. (2017). Operational issues for geological analog simulation at Eifel volcanic region: ILEWG EuroMoonMars. 48th Lunar and Planetary Science Conference LPSC, 20

- 24th March,The Woodlands, Texas. Retrieved from http://www.hou.usra.edu/meetings/lpsc2017/pdf/2997.pdf

Harrison, A. A., Clearwater, Y. A., & McKay, C. P. (1991). *From Antarctica to outer space: Life in isolation and confinement*. *From Antarctica to outer space: Life in isolation and confinement*. New York: Springer-Verlag.

Hawaii Space Exploration Analog and Simulation. (n.d.). Retrieved from https://hi-seas.org/

Haynes, N. M. (2012). *Group Dynamics: Basics and Pragmatics for Practitioners*. Blue Ridge Summit, USA: UPA. Retrieved from http://ebookcentral.proquest.com/lib/cuni/detail.action?docID=817139

Heale, R., & Forbes, D. (2013). Understanding triangulation in research. *Evidence Based Nursing*, *16*(4), 98–98. http://doi.org/10.1136/eb-2013-101494

Herian, M. N., & Desimone, J. A. (2014). *Examining Psychosocial Well-being and Performance in Isolated, Confined, and Extreme Environments Final Report*. *NASA/TM-2015-218565*. Houston, Texas. Retrieved from https://ston.jsc.nasa.gov/collections/trs/_techrep/TM-2015-218565.pdf

Hermida, J. (2006). Crimes in Space: Legal and Criminological Approach to Criminal Acts in Outer Space. *Annals of Air and Space Law*, *31*, 405–423. Retrieved from http://www.julianhermida.com/dossier/dossiercrimmcgill.pdf

Horneck, G., & Comet, B. (2006). General human health issues for Moon and Mars missions: Results from the HUMEX study. *Advances in Space Research*, *37*(1), 100–108. http://doi.org/10.1016/j.asr.2005.06.077

Horneck, G., Facius, R., Reichert, M., Rettberg, P., Seboldt, W., Manzey, D., … Gerzer, R. (2006). HUMEX, a study on the survivability and adaptation of humans to long-duration exploratory missions, part II: Missions to Mars. *Advances in Space Research*, *38*, 752–759. http://doi.org/10.1016/j.asr.2005.06.072

Horneck, G., Facius, R., Reitz, G., Rettberg, P., Baumstark-Khan, C., & Gerzer, R. (2003). Critical issues in connection with human missions to Mars: protection of and from the Martian environment. *Advances in Space Research : The Official Journal of the Committee on Space Research (COSPAR)*, *31*(1), 87–95. http://doi.org/10.1016/S0273-1177(02)00662-2

Chappell, S. P., Abercromby, A. F., Todd, W. L., & Gernhardt, M. L. (2011). Final Report of NEEMO 14: Evaluation of a Space Exploration Vehicle , Cargo Lander , and Crew Lander during Simulated Partial-gravity Exploration and Construction Tasks. *NASA/TP-2011-216152*. Retrieved from https://lsda.jsc.nasa.gov/lsda_data/dataset_inv_data/TP-2011-216152.pdf_EPSP_EPSP_CG_2014_133_010521.pdf

Cheetham, R. W. S. (1981). Psychological compatibility on earth and in outer space. *South African Medical Journal Suid-Afrikaanse Mediese Tydskrif*, *59*(14).

Ihle, E. C., Ritsher, J. B., & Kanas, N. A. (2006). Positive psychological outcomes of spaceflight: An empirical study. *Aviation Space and Environmental Medicine*, *77*(2).

IMBP. (n.d.). «Mars-500» project: Simulation of a manned flight to Mars. Retrieved January 4, 2016, from http://mars500.imbp.ru/en/index_e.html

IMBP. (2017). Isolation studies for solution of psychophysiological problems of long-term spaceflights. IMBP. Unpublished informational kit.

Inoue, N., Matsuzaki, I., & Ohshima, H. (2004). Group interactions in SFINCSS-99: Lessons for improving support programs. *Aviation Space and Environmental Medicine*, *75*(7, Suppl.), C28–C35.

Janoušek, J. (1968). *Sociální komunikace*. Praha: Svoboda.

Janoušek, J. (1986). *Metody sociální psychologie*. Praha: Státní pedagogické nakladatelství.

Jehn, K. A. (1997). A qualitative analysis of conflict types and dimensions in organizational groups. *Administrative Science Quarterly*, *42*(3), 530–557. http://doi.org/10.2307/2393737

Jehn, K. A., & Bendersky, C. (2003). Intragroup Conflict in Organizations: a Contingency Perspective on the Conflict-Outcome Relationship. *Research in Organizational Behavior*, *25*(3), 187–242. http://doi.org/10.1016/S0191-3085(03)25005-X

Jehn, K. A., & Mannix, E. A. (2001). The dynamic nature of conflict: A longitudinal study of intragroup conflict and group performance. *Academy of Management Journal*, *44*(2), 238–251. http://doi.org/10.2307/3069453

Jick, T. D. (2015). Mixing Qualitative and Quantitative Methods : Triangulation in Action Mixing Qualitative and Quantitative Methods : Triangulation in Action *, *24*(4), 602–611.

John Paul, F. U., Mandal, M. K., Ramachandran, K., & Panwar, M. R. (2010). Cognitive performance during long-term residence in a polar environment. *Journal of Environmental Psychology*, *30*(1), 129–132. http://doi.org/10.1016/j.jenvp.2009.09.007

Johnson, P. J. (2010). The roles of NASA, U.S. astronauts and their families in long-duration missions. *Acta Astronautica*, *67*(5–6), 561–571. http://doi.org/10.1016/j.actaastro.2010.05.001

Kahn, P. M., & Leon, G. R. (1994). Group Climate and Individual Functioning in an All-Women Antarctic Expedition Team. *Environment and Behavior*, *26*(5), 669–697. http://doi.org/10.1177/0013916594265004

Kanas, N. A. (1998). Psychosocial issues affecting crews during long-duration international space missions. *Acta Astronautica*, *42*(1–8), 339–361. http://doi.org/10.1016/S0094-5765(98)00130-1

Kanas, N. A. (2013). Human Interactions On-orbit. In D. A. Vakoch (Ed.), *On Orbit and Beyond: Psychological Perspectives on Human Spaceflight* (pp. 93–106). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-30583-2_5

Kanas, N. A. (2014). Psychosocial issues during an expedition to Mars. *Acta Astronautica*, *103*, 73–80. http://doi.org/10.1016/j.actaastro.2014.06.026

Kanas, N. A. (2015). *Humans in Space: The Psychological Hurdles*. Chichester, UK: Springer. http://doi.org/10.1007/978-3-319-18869-0

Kanas, N. A., & Fedderson, W. (1971). *Behavioral, Psychiatric, and Sociological Problems of Long-Duration Space Missions*. *NASA Technical Memorandum*. Houston: NASA TM X-58067. Retrieved from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19720008366.pdf

Kanas, N. A., Gushin, V. I., & Yusupova, A. (2008). Problems and possibilities of astronauts-Ground communication content analysis validity check. *Acta Astronautica*, *63*(7–10), 822–827. http://doi.org/10.1016/j.actaastro.2008.01.007

Kanas, N. A., & Manzey, D. (2008). *Space Psychology and Psychiatry*. Springer Science & Business Media. http://doi.org/10.1007/978-1-4020-6770-9

Kanas, N. A., Salnitskiy, V. P., Boyd, J. E., Gushin, V. I., Weiss, D. S., Saylor, S. A., … Marmar, C. R. (2007). Crewmember and mission control personnel interactions during international space station missions. *Aviation Space and Environmental Medicine*, *78*(6), 601–607.

Kanas, N. A., Salnitskiy, V. P., Ritsher, J. B., Gushin, V. I., Weiss, D. S., Saylor, S. A., … Marmar, C. R. (2007). Psychosocial interactions during ISS missions. *Acta Astronautica*, *60*(4–7 SPEC. ISS.), 329–335. http://doi.org/10.1016/j.actaastro.2006.09.001

Kanas, N. A., Sandal, G. M., Boyd, J. E., Gushin, V. I., Manzey, D., North, R., … Wang, J. (2009). Psychology and culture during long-duration space missions. *Acta Astronautica*, *64*(7–8), 659–677. http://doi.org/10.1016/j.actaastro.2008.12.005

Kanas, N. A., Weiss, D. S., & Marmar, C. R. (1996). Crewmember interactions during a Mir space station simulation. *Aviation, Space, and Environmental Medicine*, *67*(10), 969–975.

Kass, J. (2015). Team-Work During Long-Term Isolation : SFINCSS Experiment, (August).

Kass, J., Kass, R., & Samaltedinov, I. (1995). Psychological considerations of man in space: Problems & solutions. *Acta Astronautica*, *36*(8–12), 657–660. http://doi.org/10.1016/0094-5765(95)00155-7

Kimhi, S. (2011). Understanding Good Coping: A Submarine Crew Coping with Extreme Environmental Conditions. *Psychology*, *2*(9), 961–968. http://doi.org/10.4236/psych.2011.29145

Kołodziejczyk, A. M., Ambroszkiewicz, G., Budzyń, D., Davidova, L., Foing, B., Gawlak, M., … Zagórski, P. (2017). Analogue Simulation of Lunar Environment – Lessons Learned from the first Lunar Campaign in Poland. In *European Lunar Symposium*. Münster, Germany.

Kołodziejczyk, A. M., Harasymczuk, M., Girardin, P., & Davidová, L. (2017). Circadian Clock and Subjective Time Perception: A Simple Open Source Application for the Analysis of Induced Time Perception in Humans. *World Academy of Science, Engineering and Technology, International Journal of Medical, Health, Biomedical, Bioengineering and Pharmaceutical Engineering*, *11*(3), 101–107. Retrieved from http://waset.org/publications/10006675/circadian-clock-and-subjective-time-perception-a-simple-open-source-application-for-the-analysis-of-induced-time-perception-in-humans

Korsgaard, M. A., Soyoung Jeong, S., Mahony, D. M., & Pitariu, A. H. (2008). A Multilevel

View of Intragroup Conflict. *Journal of Management*, *34*(6), 1222–1252. http://doi.org/10.1177/0149206308325124

Kozlowski, S. W. (n.d.). Special issue: Dynamic relationship in teams: Advancing Research on Team Process Dynamics: Theoretical, Methodological, and Measurement Considerations. Retrieved August 12, 2015, from http://iopsych.msu.edu/koz/Recent Pubs/Kozlowski (in press) - Team Dynamics.pdf

Lačev, A., Srb, T., Bahbouh, R., Höschl, C., Sýkora, J., & Poláčková Šolcová, I. (2012). Využití sociomapování při experimentech simulovaných letů na Mars. In R. Bahbouh, E. Rozehnalová, & V. Sailerová (Eds.), *Nové pohledy psychodiagnostiky* (pp. 81–95). Prague: QED GROUP.

Lačev, A., Sýkora, J., Bahbouh, R., Lukáš, R., & Höschl, C. (2012). Sociomapping of the Crew Cooperation and Performance in the Mars 500 Spaceflight Simulation. In R. Bahbouh & G. Lasker (Eds.), *Sociodiagnostics and sociomapping*. The International Institute for Advanced Studies in Systems Research and Cybernetics.

Latorella, K. A., & Prabhu, P. V. (2000). A review of human error in aviation maintenance and inspection. *International Journal of Industrial Ergonomics*, *26*(2), 133–161. http://doi.org/10.1016/S0169-8141(99)00063-3

Leach, J. (2016). Psychological factors in exceptional, extreme and torturous environments. *Extreme Physiology & Medicine*, *5*, 7. http://doi.org/10.1186/s13728-016-0048-y

Lebeděv, V. (1988). *Diary of a Cosmonaut: 211 Days in Space.* Texas: Phytoresource Research Information Service.

Leon, G. R., Sandal, G. M., & Larsen, E. (2011). Human performance in polar environments. *Journal of Environmental Psychology*, *31*(4), 353–360. http://doi.org/10.1016/j.jenvp.2011.08.001

Lingard, L., Espin, S., Whyte, S., Regehr, G., Baker, G. R., Reznick, R., … Grober, E. (2004). Communication failures in the operating room: an observational classification of recurrent types and effects. *Quality & Safety In Health Care*, *13*(5), 330–4. http://doi.org/10.1136/qhc.13.5.330

Loomis, C. P., & Pepinsky, H. B. (2015). Sociometry, 1937-1947: Theory and Methods, *11*(3), 262–286.

Lott, B. E., & Lott, A. J. (1965). Group Cohesiveness as Interpersonal Attraction: A Review of Relationships with Antecedent and Consequent Variables. *Psychological Bulletin*, *64*(4), 259–309. http://doi.org/10.1037/h0022386

Lugg, D., & Shepanek, M. (1999). Space analogue studies in Antarctica. *Acta Astronautica*, *44*(7), 693–699. http://doi.org/10.1016/S0094-5765(99)00068-5

M.A.R.S. Modular Analog Research Station. (n.d.). Retrieved March 22, 2017, from http://marshub.org

MacCallum, T., & Poynter, J. (1995). Factors affecting human performance in the isolated confined environment of Biosphere 2. *Third Annual Mid-Atlantic Human Factors Conference*. Retrieved from http://janepoynter.com/documents/Bio2factorsaffectingperformance.pdf

Maccallum, T., Poynter, J., & Bearden, D. (2004). Lessons Learned From Biosphere 2: When Viewed as a Ground Simulation/Analog for Long Duration Human Space Exploration and Settlement. In *In International Conference On Environmental Systems*.

Manzey, D. (2004). Human missions to Mars: New psychological challenges and research issues. *Acta Astronautica*, *55*, 781–790. http://doi.org/10.1016/j.actaastro.2004.05.013

Mohanty, S., Fairburn, S., Imhof, B., Ransom, S., & Vogler, A. (2008). Survey of Past , Present and Planned Human Space Mission Simulators. In *Proceedings of the 38th International Conference on Environmental Systems*. San Francisco, California (Vol. 29). http://doi.org/10.4271/2008-01-2020

Muller, H. K., Lugg, D. J., Ursin, H., Quinn, D., & Donovan, K. (1995). Immune responses during an Antarctic summer. *Pathology*, *27*(2), 186–190. Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=7567151

Mullin, C. S. (1960). Some psychological aspects of isolated Antarctic living. *The American Journal of Psychiatry*, *117*(4), 323–325.

Musk, E. (2016). Making Humans a Multiplanetary Species. Retrieved January 1, 2017, from http://www.spacex.com/mars

NASA. (n.d.-a). Constellation Program: America's Spacecraft for a New Generation of Explorers The Orion Crew Exploration Vehicle. Retrieved January 22, 2017, from https://www.nasa.gov/pdf/166914main_FS_Orion508c.pdf

NASA. (n.d.-b). HERA. Retrieved March 31, 2017, from https://www.nasa.gov/analogs/hera

NASA. (n.d.-c). International Space Station: Past Expeditions. Retrieved February 22, 2017, from https://www.nasa.gov/mission_pages/station/expeditions/past.html

NASA. (n.d.-d). Orion: Quick Facts. Retrieved January 22, 2017, from https://www.nasa.gov/sites/default/files/atoms/files/fs-2014-08-004-jsc-orion_quickfacts-web.pdf

NASA. (n.d.-e). Space Analog Environments. Retrieved January 9, 2016, from https://www.nasa.gov/centers/johnson/pdf/639727main_Space_Analog_Environments_FTI.pdf

NASA. (2011). NASA's Analog Missions: Paving the Way for Space Exploration. Retrieved February 22, 2017, from https://www.nasa.gov/sites/default/files/563511main_NASA-Analog-Missions-06-2011_508.pdf

Nelson, M., Gray, K., & Allen, J. P. (2015). Group dynamics challenges: Insights from Biosphere 2 experiments. *Life Sciences in Space Research*, *6*(December), 79–86. http://doi.org/http://dx.doi.org/10.1016/j.lssr.2015.07.003

Newcomb, T. M. (1956). The prediction of interpersonal attraction. *American Psychologist*, *11*(11), 575–586.

Nice, D. S. (1981). A longitudinal analysis of Navy family separation. Retrieved January 31, 2017, from http://www.dtic.mil/dtic/tr/fulltext/u2/a108381.pdf

Nicolas, M., Sandal, G. M., Weiss, K., & Yusupova, A. (2013). Mars-105 study: Time-courses and relationships between coping, defense mechanisms, emotions and depression. *Journal of Environmental Psychology*, *35*, 52–58. http://doi.org/10.1016/j.jenvp.2013.05.001

O'Reilly, C. A., & Roberts, K. H. (1975). Credibility and Communication. Retrieved January 2, 2015, from http://digitalassets.lib.berkeley.edu/irle/ucb/text/ir000281.pdf

Oberg, J. (2005). Does Mars need women? Russians say no. Retrieved December 10, 2015, from http://www.nbcnews.com/id/6955149/ns/technology_and_science-space/t/does-mars-need-women-russians-say-no/#.V0to4HxkjIU

Orlov, O. I., Belakovsky, M. S., & Ponomarev, S. A. (2016). A Moon of Their Own. Retrieved

March 20, 2017, from https://room.eu.com/article/A_Moon_of_Their_Own

Palinkas, L. A. (2001). Psychological Issues in Long-Term Space flight: Overview. *Gravitational and Space Biology Bulletin*, *14*(June), 25–33.

Palinkas, L. A. (2003). The psychology of isolated and confined environments: Understanding human behavior in Antarctica. *The American Psychologist*, *58*(5), 353–363. http://doi.org/10.1037/0003-066X.58.5.353

Palinkas, L. A., Gunderson, E. K. E., Johnson, J. C., & Holland, A. W. (2000). Behavior and performance on long-duration spaceflights: Evidence from analogue environments. *Aviation Space and Environmental Medicine*, *71*(9), A29–A36. Retrieved from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20000068515.pdf

Palinkas, L. A., & Suedfeld, P. (2008). Psychological effects of polar expeditions. *The Lancet*, *371*(9607), 153–163. http://doi.org/10.1016/S0140-6736(07)61056-3

Peldszus, R., Dalke, H., Pretlove, S., & Welch, C. (2014). The perfect boring situation - Addressing the experience of monotony during crewed deep space missions through habitability design. *Acta Astronautica*, *94*(1), 262–276. http://doi.org/10.1016/j.actaastro.2013.04.024

Perchonok, M., & Bourland, C. (2002). NASA food systems: Past, present, and future. *Nutrition*, *18*(10), 913–920. http://doi.org/10.1016/S0899-9007(02)00910-3

Peterson, R. S., & Behfar, K. J. (2003). The dynamic relationship between performance feedback, trust, and conflict in groups: A longitudinal study. *Organizational Behavior and Human Decision Processes*, *92*(1–2), 102–112. http://doi.org/10.1016/S0749-5978(03)00090-6

Petrusek, M. (1969). *Sociometrie. Sociologická knižnice, Svoboda, Praha.* Praha: Sociologická knižnice, Svoboda.

Poland Mars Analogue Simulation 2017. (n.d.). Retrieved August 27, 2016, from http://spacegeneration.org/index.php?option=com_content&view=article&id=1686&catid=127&Itemid=2847#TOP

Prada, R., Ma, S., & Nunes, M. A. (2009). Personality in Social Group Dynamics. *International Conference on Computational Science and Engineering*, 607–612. http://doi.org/10.1109/CSE.2009.24

Rasmussen, J. (1982). Human errors. A taxonomy for describing human malfunction in industrial installations. *Journal of Occupational Accidents*, *4*(2–4), 311–333.

Reagan, M. L., Janoiko, B. A., Parker, M. L., & Johnson, J. E. (2012). NASA's analog missions: Driving exploration through innovative testing. *AIAA SPACE 2012 Conference & Exposition*, 1–18. http://doi.org/doi:10.2514/6.2012-5238

Reyes, M. de los, Binder, H., & Kraft, N. O. (2004). Perception and friction between crews and their visitors during long duration isolation (pp. 1–13). Vancouver: 55th International Astronautical Congress, Vancouver, Canada.

Robinson, J. A., Slack, K. J., Olson, V., Trenchard, M. H., Willis, K. J., Baskin, P. J., & Boyd, J. E. (2011). Patterns in Crew-Initiated Photography of Earth from the ISS: Is Earth Observation a Salutogenic Experience? In D. A. Vakoch (Ed.), *Psychology of Space Exploration: Contemporary Research in Historical Perspective* (pp. 79–101). Washington DC: NASA.

Ronca, A. E., Baker, E. S., Bavendam, T. G., Beck, K. D., Miller, V. M., Tash, J. S., & Jenkins, M. (2014). Effects of sex and gender on adaptations to space: reproductive health. *Journal of Women's Health*, *23*(11), 967–74. http://doi.org/10.1089/jwh.2014.4915

Rosnet, E., Caves, G., & Vinokhodova, A. G. (1998). Study of the psychological adaptation of the crew during 135 days space simulation. *Acta Astronautica*, *42*(1), 265–272.

Rozehnalová, E. (2008). *Sociomapování pracovních týmů (Sociomapping of work teams)*. Charles University in Prague. Unpublished master's thesis.

Rubin, J. Z., Pruitt, D. G., & Kim, S. H. (1986). *Social conflict: Escalation, stalemate, and settlement*. Mcgraw-Hill Book Company.

Salas, E., Tannenbaum, S. I., Kozlowski, S. W. J., Miller, C. A., Mathieu, J. E., & Vessey, W. B. (2015). Teams in Space Exploration: A New Frontier for the Science of Team Effectiveness. *Current Directions in Psychological Science*, *24*(3), 200–207. http://doi.org/10.1177/0963721414566448

Salotti, J. M., & Heidmann, R. (2014). Roadmap to a human Mars mission. *Acta Astronautica*, *104*(2), 558–564. http://doi.org/10.1016/j.actaastro.2014.06.038

Salotti, J. M., & Suhir, E. (2014). Manned missions to Mars: Minimizing risks of failure. *Acta Astronautica*, *93*, 148–161. http://doi.org/10.1016/j.actaastro.2013.07.005

Sandal, G. M. (2001). Psychosocial issues in space: Future challenges. *Gravitational and Space Biology Bulletin*, *14*(2), 47–54.

Sandal, G. M. (2002). Individual and group adaptation in space: Evidence from analogue environments. *Journal of Gravitational Physiology: A Journal of the International Society for Gravitational Physiology*, *9*(1), 367–368.

Sandal, G. M., & Bye, H. H. (2015). Value diversity and crew relationships during a simulated space flight to Mars. *Acta Astronautica*, *114*, 164–173. http://doi.org/10.1016/j.actaastro.2015.05.004

Sandal, G. M., Bye, H. H., & van de Vijver, F. J. R. (2011). Personal values and crew compatibility: Results from a 105 days simulated space mission. *Acta Astronautica*, *69*(3–4), 141–149. http://doi.org/10.1016/j.actaastro.2011.02.007

Sandal, G. M., Vaernes, R. J., & Ursin, H. (1995). Interpersonal relations during simulated space missions. *Aviation, Space, and Environmental Medicine*, *66*(7), 617–624.

Sandal, G. M., Værnes, R., & Ursin, H. (1996). Crew compatibility and interaction. *Advances in Space Biology and Medicine*, *5*, 213–231.

Selfhout, M., Denissen, J., Branje, S., & Meeus, W. (2009). In the eye of the beholder: Perceived, actual, and peer-rated similarity in personality, communication, and friendship intensity during the acquaintanceship process. *Journal of Personality and Social Psychology*, *96*(6), 1152–1165. http://doi.org/10.1037/a0014468

Shved, D. M., Gushin, V. I., Ehmann, B., & Balazs, L. (2013). [Characteristics of the signal lag effect on crew-control center communications in the 520-day simulation experiment]. *Aviakosmicheskaia I Ekologicheskaia Meditsina= Aerospace and Environmental Medicine*, *47*(3), 19–23.

Shved, D. M., Gushin, V. I., Vinokhodova, A. G., Nichiporuk, I. A., & Vasilieva, G. Y. (2014). Psychophysiological adaptation and communication behavior of a human operator during 105-day isolation. *Human Physiology*, *40*(7), 797–803. http://doi.org/10.1134/S036211971407024X

Schlacht, I. L., Foing, B., Bannova, O., Blok, F., Mangeot, A., Nebergall, K., … Kolodziejczyk, A. M. (2016). Space Analog Survey: Review of Existing and New Proposal of Space Habitats with Earth Applications. In *46th International Conference on Environmental*

Systems. Vienna, Austria. Retrieved from https://ttu-ir.tdl.org/ttu-ir/handle/2346/67692

Schlacht, I. L., Punch, O., Foing, B., Kolodziejczyk, A. M., Cowley, A., & Ceppi, G. (2016). Design for the future: FLEXHAB project, the future Lunar exploration habitat; M.A.R.S.; and EXOHAB (p. 6). 67th International Astronautical Congress, Guadalajara, Mexico. Retrieved from http://esamultimedia.esa.int/docs/Mars500/ESA_Mars_500InfoKit_31May2010.pdf

Sociomapping. (n.d.). Retrieved December 22, 2016, from www.sociomapping.com

Spring, G. (2010). Mars 500 isolation study: Information Kit. Retrieved November 11, 2016, from http://esamultimedia.esa.int/docs/Mars500/ESA_Mars_500InfoKit_31May2010.pdf

Srb, T., Bahbouh, R., & Sýkora, J. (2012). Závěrečná zpráva z pilotní části experimentu Mars-500/105: Využití sociomapování komunikace a spolupráce posádky jako nástroje pro řízení výkonnosti týmu v pozemním experimentu simulujícím let na Mars. QED GROUP.

Strollo, F., Vassilieva, G. Y., Ruscica, M., Masini, M., Santucci, D., Borgia, L., … Nikiporuc, I. (2014). Changes in stress hormones and metabolism during a 105-day simulated Mars mission. *Aviation, Space, and Environmental Medicine*, *85*(8), 793–7. http://doi.org/10.3357/ASEM.3907.2014

Stuster, J. W. (1986). Space Station Habitability: Recommendations Based on a Systematic Comparative Analysis of Analogous Conditions, 230.

Stuster, J. W. (2000). Bold endeavors: behavioral lessons from polar and space exploration. *Gravitational and Space Biology Bulletin : Publication of the American Society for Gravitational and Space Biology*, *13*(2), 49–57. http://doi.org/multi:Further reading...;Sleep is one of the most challenging aspects...; “free-running”...

Suedfeld, P. (2005). Invulnerability, coping, salutogenesis, integration: four phases of space psychology. *Aviation, Space, and Environmental Medicine*, *76*(6), B61--B66.

Suedfeld, P. (2010). Historical space psychology: Early terrestrial explorations as Mars analogues. *Planetary and Space Science*, *58*(4), 639–645. http://doi.org/10.1016/j.pss.2009.05.010

Sýkora, J. (1989). Závěrečná výzkumná zpráva z experimentu ŠTOLA-88. Praha: Fyziologický ústav ČSAV.

Sýkora, J. (1996). Research activities of the expert laboratory IAFAD introductory presentation.

In *Selection and Training Advances in Aviation*. AGARD. Papers presented at the Aerospace Medical Panel Symposium held in Prague, Czech Republic, May 1996.

Sýkora, J., Dvořák, J., Bahbouh, R., Bernardova, K., & Justa, K. (2010). Results of the laboratory simulation of long lasting space flights in Czech Republic including former Czechoslovakia. *61st International Astronautical Congress 2010, IAC 2010*, *12*, 10144–10148. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-79959440181&partnerID=40&md5=beb27524a6141b353a81c23d6364ca0b

Sýkora, J., Šolcová, I., Dvořák, J., Polánková, M., & Tomeček, A. (1996). Women's place in space exploration. *Space Policy*, *12*(3), 161–165.

Šolcová, I., Gushin, V. I., Vinokhodova, A. G., & Lukavský, J. (2013). Emotional energy, work self-efficacy, and perceived similarity during the mars 520 study. *Aviation Space and Environmental Medicine*, *84*(11), 1186–1190. http://doi.org/10.3357/ASEM.3679.2013

Šolcová, I., Stuchlíková, I., & Guščin, I. V (Eds.). (2014). *Mars-500: Fakta a postřehy ze simulovaného letu na rudou planetu*. Praha: Academia.

Tafforin, C. (1993). Ethological analysis of spatial behavior. *Advances in Space Biology and Medicine*, *3*, 81–94.

Tafforin, C. (2004). Ethological analysis of a polar team in the French Antarctic station Dumont d'Urville as simulation of space teams for future interplanetary missions. *Acta Astronautica*, *55*, 51–60. http://doi.org/10.1016/j.actaastro.2003.12.015

Tafforin, C. (2005). Ethological indicators of isolated and confined teams in the perspective of missions to Mars. *Aviation Space and Environmental Medicine*, *76*(11), 1083–1087. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-27744526587&partnerID=40&md5=0085544fadca6ff62ff25c6c15881889

Tafforin, C. (2013). The Mars-500 crew in daily life activities: An ethological study. *Acta Astronautica*, *91*, 69–76. http://doi.org/10.1016/j.actaastro.2013.05.001

Tafforin, C., Vinokhodova, A. G., Chekalina, A., & Gushin, V. I. (2015). Correlation of etho-social and psycho-social data from "Mars-500" interplanetary simulation. *Acta Astronautica*, *111*, 19–28. http://doi.org/10.1016/j.actaastro.2015.02.005

Tajfel, H. (1970). Experiments in intergroup discrimination. *Scientific American*, *223*(5), 96–102. http://doi.org/10.1038/scientificamerican1170-96

The Mars Society. (n.d.). Retrieved January 16, 2017, from www.marssociety.org

Todd, W., & Reagan, M. (2003). The NEEMO Project: A Report on how NASA Utilizes the "Aquarius" Undersea Habitat as an Analog for Long-Duration Space Flight. *NASA*, 1–11. http://doi.org/10.1061/40722(153)103

Trickey, M. (2000, March 25). Canadian scientist livid over Russians' response to space kiss. *National Post*. Toronto. Retrieved from http://business.highbeam.com/435424/article-1G1-61943814/canadian-scientist-livid-over-russians-response-space

Tuckman, B. W. (1965). Developmental sequence in small groups. *Psychological Bulletin*, *63*(6), 384–399. http://doi.org/10.1037/h0022100

Tuckman, B. W., & Jensen, M. A. C. (1977). Stages of small-group development revisited. *Group & Organisation Management*, *2*(4), 419–427. http://doi.org/10.1177/105960117700200404

Urbina, D. A., & Charles, R. (2014). Symposium keynote: Enduring the isolation of interplanetary travel. *Acta Astronautica*, *93*, 374–383. http://doi.org/10.1016/j.actaastro.2013.07.028

Ursin, H., Comet, B., & Soulez-Larivière, C. (1992). An attempt to determine the ideal psychological profiles for crews of long term space missions. *Advances in Space Research: The Official Journal of the Committee on Space Research (COSPAR)*, *12*(1), 301–14. http://doi.org/10.1016/0273-1177(92)90298-C

Ushakov, I. B., Gushin, V. I., Larina, I. M., Shved, D. M., Pastushkova, I. K., & Vinokhodova, A. G. (2012). Content and structure of crew's communicative behavior and gonadal hormone excretion during long-term chamber isolation of all-male international crew. *Human Physiology*, *38*(6), 640–648. http://doi.org/10.1134/s036211971206014x

Ushakov, I. B., Morukov, B. V, Bubeev, Y. A., Gushin, V. I., Vasilieva, G. Y., Vinokhodova, A. G., & Shved, D. M. (2015). Main findings of psychophysiological studies in "MARS-500" experiment. Human in Space Symposium held in Prague, 2015.

Ushakov, I. B., Vladimirovich, M. B., Bubeev, Y. A., Gushin, V. I., Vasilieva, G. Y., Vinokhodova, A. G., & Shved, D. M. (2014). Main findings of psychophysiological studies in the Mars 500 experiment. *Herald of the Russian Academy of Sciences*, *84*(2), 106–114. http://doi.org/10.1134/S1019331614020063

Vaernes, R. J. (1996). EXEMSI: Description of facilities, organization, crew selection, and operational aspects. *Advances in Space Biology and Medicinen Space Biology and Medicine*, *5*, 7–38. http://doi.org/https://doi.org/10.1016/S1569-2574(08)60051-9

Værnes, R. J. (1996). Lessons Learned from ISEMSI and EXEMSI. *Advances in Space Biology and Medicine*, *5*, 375–396. http://doi.org/https://doi.org/10.1016/S1569-2574(08)60071-4

Vaernes, R. J., Bergan, T., Warncke, M., Ursin, H., Aakvaag, A., & Hockey, R. (1993). Workload and stress: Effects on psychosomatic and psychobiological reaction patterns. *Advances in Space Biology and Medicine*, *3*, 95–120. http://doi.org/https://doi.org/10.1016/S1569-2574(08)60099-4

Vaernes, R. J., Schernhardt, A., Sundland, H., & Thorsen, E. (1993). General description of ISEMSI: Technical scenario, selection of candidtes, operational aspects, and organization. *Advances in Space Biology and Medicine*, *3*, 35–58. http://doi.org/https://doi.org/10.1016/S1569-2574(08)60096-9

Vinokhodova, A. G., Gushin, V. I., Eskov, K. N., & Khananashvili, M. M. (2012). Psychological selection and optimization of interpersonal relationships in an experiment with 105-days isolation. *Human Physiology*, *38*(7), 677–682. http://doi.org/10.1134/S0362119712070262

Von Braun, W. (1953). *Mars Project*. Urbana: University of Illinois Press.

Walford, R. L., Harris, S. B., Gunion, M. W., Sciences, M., Ventures, S. B., & Angeles, L. (1992). The calorically restricted low-fat nutrient-dense diet in Biosphere 2 significantly lowers blood glucose, total leukocyte count, cholesterol, and blood pressure in humans. *Proceedings of the National Academy of Sciences of the United States of America*, *89*(23), 11533–11537. http://doi.org/10.1073/pnas.89.23.11533

Wall, J. A. J., & Callister, R. R. (1995). Conflict and Its Management. *Journal of Management*, *21*(3), 515–558. http://doi.org/10.1177/014920639502100306

Weybrew, B. B. (1991). Three decades of nuclear submarine research: implications for space and Antarctic research. In A. A. Harrison, Y. A. Clearwater, & C. P. McKay (Eds.), *From Antarctica to Outer Space: Life in Isolation and Confinement* (pp. 103–114). New York: Springer.

Wheelan, S. a., Davidson, B., & Tilin, F. (2003). Group development across time: Reality or illusion? *Small Group Research*, *34*(2), 223–245. http://doi.org/10.1177/1046496403251608

Wikipedia. (n.d.). List of International Space Station expeditions. Retrieved March 22, 2017, from https://en.wikipedia.org/wiki/List_of_International_Space_Station_expeditions

Winsor, D. A. (1988). Communication failures contributing to the Challenger accident: An example for technical communicators. *IEEE Transactions on Professional Communication*, *31*(3), 101–107. http://doi.org/10.1109/47.7814

Woerner, J. (n.d.). Moon Village: A vision for global cooperation and Space 4.0. Retrieved from http://www.esa.int/About_Us/Ministerial_Council_2016/Moon_Village

Woerner, J., & Foing, B. (2016). The "Moon Village" concept and initiative. Annual Meeting of the Lunar Exploration Analysis Group, held 1-3 November, 2016 in Columbia, Maryland.

Wood, J., Lugg, D. J., Hysong, S., & Harm, D. L. (1999). Psychological Adaptation to Extreme Environments: Effects of Team Composition on Individual Adaptation. *Environnment and Behavior*, *31*(3), 299–337.

Wu, R., & Wang, Y. (2015). Psychosocial interaction during a 105-day isolated mission in Lunar Palace 1. *Acta Astronautica*, *113*, 1–7. http://doi.org/10.1016/j.actaastro.2015.03.032

Zimmer, M., Cabral, J. C. C. R., Borges, F. C., Côco, K. G., & Hameister, B. da R. (2013). Psychological changes arising from an Antarctic stay: systematic overview. *Estudos de Psicologia (Campinas)*, *30*(3), 415–423. http://doi.org/10.1590/S0103-166X2013000300011