Antrocom Online Journal of Anthropology vol. 12. n. 2 (2016) 97-110 – ISSN 1973 – 2880

Antrocom Journal of Anthropology

journal homepage: http://www.antrocom.net

Interaction and communication abilities in a multicultural crew simulating living and working habits at Mars Desert Research Station

Carole Tafforin[1], Francisco Giner Abati[2]

[1] Director, Research and Study Group in Human and Space Ethology, Ethospace, Toulouse, France; ethospace@orange.fr; [2] Professor, Department of Social Psychology and Anthropology, University of Salamanca, Spain; abati@usal.es.

KEYWORDS

Human ethology; cultural anthropology; language; adaptation; confinement; small group

ABSTRACT

Future interplanetary crewmembers will be micro-societies like autonomous and auto-organized systems far from the Earth. They will have to live and work together in small habitat units as it is simulated at Mars Desert Research Station (MDRS) in Utah, USA. Missions become longer and the multi-national heterogeneity of the crews becomes new characteristics to emphasize. The purpose of this study is to combine ethological and anthropological methods for quantitative and qualitative descriptions of the crew's non-verbal and verbal behavior during a 15-day period, characterized by a multicultural background (French, Danish, Australian and American). The results show global high occurrences of visual interactions compared to both facial, body and object interactions. Differences of language skill have an impact on communication abilities. Subjects using no-native languages compensate with interaction abilities. With the evolving of common working and living habits, some will actively interact, others will actively communicate and the whole will be involved in dynamic process of adaptation with cultural diversity as salutogenic factor.

Introduction

When considering that cultural anthropology works on small groups sometimes far from modern civilization and in isolated environments, such an approach opens new perspectives of research for deep space exploration. So far, human ethology worked from this perspective providing a quantitative methodology. During short-term orbital missions as well as long-duration interplanetary trip simulations, results showed the behavioral adaptation of the crews at personal as well as social level (Tafforin 1999:5-7; 2015a:3-5). Specifically, we observed that non-verbal behaviors expressed through motor activities, body displacements, facial mimics, collateral actions and spatial positions changed according to a dynamic process. For instance, in confinement and isolation period that simulated living and working conditions of small groups during extended periods of time forerunning missions to Mars, we analyzed the inter-individual distances following Hall's classification (1971:148-157). He defined four classes of distances in terms of intimate space, personal space, social space and public space. We found that in large and open areas, inter-individual distances were constant whereas in reduced habitats, the frequency of crewmembers' personal space decreased and the frequency of public space increased with high level of social space observed from the initial period to the final period of simulations (Tafforin 2005:1085). In other analog environments during polar stays, i.e. the Tara expedition in the Arctic and the Concordia base in the Antarctic continent (Tafforin 2015b), place preferences of the team-members were influenced by both nationalities and individualities. We also found cultural influences, individual differences and time effects in the dynamics process of adaptation during the very long duration of the Mars 500-d experiment, when a multinational crew simulated

Please cite this article as: Tafforin C., Giner Abati F., Interaction and communication abilities in a multicultural crew simulating living and working habits at Mars Desert Research Station. Antrocom J. of Anthropology 12-2 (2016) pp. 97-110.

daily life activities in an interplanetary mission-like confinement and isolation conditions (Tafforin 2013a:71; 2013b:4).

Culture and space are key concepts in the anthropological approach (Kokot 2007:10) involving a qualitative methodology. For instance, among the Himbas of Namibia in Africa, as in many other small-scale societies, dwellings are small living spaces and the social space is made of grouped huts (Giner Abati 1992:47-50). In other geographical settings, there are small ethnic groups such as the Tasaday in the Philippine island of Mindanao that are isolated to prevent risks of illness, and the aboriginal people of the Andaman Islands in the bay of Bengal that are isolated to preserve their territory from interloping outsiders. Living habits, social rules and the resulting cultural imprint are qualitative features of groups, teams or crews whatever their environments and whereabouts.

With the challenge of future interplanetary missions that may be short trips on the Moon and on Asteroids, or a long trip to Mars, the scope of the present paper is to enrich researches on the human behavior in space by taking into account the culture of the space travellers that will evolve in micro-societies as autonomous and auto-organized systems far from Earth. Our general hypothesis is that cultural diversity offered by the crews' multi-national heterogeneity is a salutogenic factor for the mission success, from the preparation, the selection to the adaptation processes.

In the previous literature, space operations have been assumed to represent multi-national efforts of co-working people from different ethnical, professional and organizational backgrounds (Sandal and Manzey 2009:1520). These cross-cultural issues were considered problems from the ground personnel operating during International Space Station (ISS) missions but also from the space crews onboard. At first, increases in the heterogeneity of space crew's composition (culture and gender differences) were reckoned a risk factor that could influence the formation of a cohesive group negatively and a common way of perceiving one's social environment (Gushin, Pustynnikova and Smirnova 2001). In Kanas's working group (2009:661) on psychology and culture during long-duration space missions, emotional expressivity, depressed mood, cognitive styles, social norms, language skills, cultural minority membership are all elements of the crewmembers' diversity and heterogeneity that may impact on conflict, tension and cohesion. Differences in patterns of mood states were previously emphasized with a particular focus on the American and Russian nationalities. Astronauts (US) manifested distress differently than cosmonauts (RU) during missions aboard ISS (Boyd et al. 2007:670). The former experienced fatigue and the latter anxiety. With complementary studies aboard the orbital Mir station, Americans scored higher on a measure of work pressure and scored lower on a measure of tension than Russians (Kanas 2016:1). From this point of view, previous works point out the negative effects of multicultural crews.

A recent review of psychology in space exploration (Douglas 2011) mitigates these findings. Cross-cultural studies in space simulation, analog environments and real missions are at an early stage. During the first manned missions in low orbit, the composition of exploring groups was based on same nationality, similar profession and mono-gender. The impact on behavioral health and operational performance was minimal. But future exploration missions are new steps in the evolution of humans in deep space. Beside possible negative impacts early during a mission, differences among crewmembers can become an asset when monotony and homesickness occur and when they seek out novel ideas and relationships (Kanas, 2015:53). Despite the language barriers limiting communication among expedition members of polar missions (Ursin et al. 1990:45), they responded positively to a multicultural experience and reported the multicultural richness of relationships within the winter-over group (Etienne 1990). A more recent expedition at Ny-Alesoud Arctic Base (Gourinat et al.

2010:74-77) has shown the efficiency of a transverse visiting multidisciplinary team for training and synergies with the polar scientists (glaciologists, geologists, specialists of the atmosphere). In fact, it is important to consider the individual, man or woman, in an organizational culture, different backgrounds and with his or her own personality traits (Sarris 2006:356; Palinkas and Suedfeld 2008) and personal values (Sandal, Bye and Van de Vijver 2013:135-148). With the Mars mission objective and with the idea that autonomy would avoid communication difficulties with the Ground crew (Kanas et al. 2010:737; Gushin et al. 2012:55); Feichtinger et al. 2013:2), the Martian crew would require to become optimal in multinational, multi-professional and mixed-gender relationships. Hence, it is of prime importance to consider the cultural values of the group (Tafforin and Giner Abati 2016:9). A personal account of the Mars 500-d experiment said that multi-culture was seen as an asset rather than a liability because the crewpersons attempted to understand each other and looked for the others new stores of knowledge (Urbina and Charles 2014:380) originating from their own living and working experiences. Intercultural cooperation in space (Draguns and Harrison 2011:193) thus becomes a positive source from inter-individual differences. At the bottom it involves a dimension of human relations that varies from conflicting and stressful to harmonious and effective (Berry 2004:52). Therefore, crewpersons with contrasting skills, values and experiences should learn to cooperate not as equals (Love and Bealcher 2013:318) but as universals within ethnic relations.

From this new point of view, positive effects of space missions on behavioral health are less frequently analyzed. The experience of being in space is a powerful one that is likely to have an enduring, positive impact on the crewmembers well being and improve mental health (Ritsher et al. 2005:630). This salutogenic experience was particularly emphasized in Suedfeld's studies (2000, 2001, 2005, 2011) by means of the application of behavioral sciences in space. Belonging to an elite team, effective group cooperation, interdependence, mutual help, and friendship were some positive social aspects in space crew dynamics (Suedfeld, 2005:61; Suedfeld and Brcic 2011:24). Lessons from a series of studies from orbital flights stated that individuals who adapt positively to extreme environments could derive benefit from their experiences (Ritsher et al. 2007:336). It has been found that inter-individual and communication competence, along with intercultural training (Weeks and Ashkar 2016:1), can have a decisive impact on future mission success (Kraft, Lyons and Binder 2003:575). Thus selecting a group vs. individuals would be a facilitating factor. Today, there is increasing evidence for emotional fitting in groups but also within cultures in terrestrial environments (Leersnyder et al. 2014:241) while interactions in isolated and confined environments have gained attention (Wu and Wang 2015:1). A new goal of research is the salutogenic dimension in behavioral differences within a multicultural crew.

Our working hypotheses deal with differences about verbal and non-verbal behavior according to crewmembers national background based on communication and interaction abilities. We propose the ethological approach that uses quantitative descriptions of the observed behaviors and the anthropological approach for the qualitative interpretations of the obtained results. With the goal of applying these analysis tools in the fieldwork, we present Mars Desert Research Station (MDRS) located in the United States, in the Utah desert that has a geological profile similar to the Martian surface.

Methods and observation situations

The ethological method is a noninvasive approach based on observation, description and quantification of spontaneous non-verbal behavior, verbal behavior and spatial behavior in daily life activities such as meal time when we chose to analyze inter-personal manifestations. The analysis is supplied with a software based-solution, The Observer XT®, designed to organize and process

observational data collected in life or from video recordings (Tafforin and Gerebtzoff 2010:952). In the chosen situation of observations, at MDRS, we collected the data from two video cameras (see fig. 1) and focused on four interaction descriptors and two communication descriptors. *Visual interactions* described any looks and glances directed toward one subject or all the subjects (crew). *Object interactions* described any manipulations on physical objects involving two subjects. *Body interactions* described all physical contacts between two subjects. *Facial expressions* described certain face movements such as smiling and laughing, as positive events related to well-being and good spirit. As complementary data, we added personal actions such as *collateral acts* that described any small movements with no manifested functions but related to stress and fatigue. *Verbal communications* described the interactions using English language as native language and non-native language. During data processing at the laboratory, we measured these behavioral events according to nonparametric descriptive statistics on duration in case of state events and on frequency in case of point events (Tafforin 2015c:133). Significant comparative results were calculated on chi-square tests with probability value (p).

As a complementary approach, the anthropological method develops qualitative descriptions of usual behaviors in daily life activities and focuses on rules for living, working habits and specific customs and values (Giner Abati, 1995: 273-9). Meal times are relevant activities from this perspective. Correlated to the quantitative descriptions, such new data analysis contributed to better understanding the context of observed inter-individual behaviors in multicultural crews during collective tasks.

MDRS offers observation situations where interplanetary crews simulate intra-vehicular activities (IVA) and extra-vehicular activities (EVA) during successive 15-day periods. The habitat is a 2-deck facility and has a 500 m^3 total volume. The upper deck includes sleeping quarters, a communal living area, a small galley, an exercise area and hygiene facilities with closed-circle water purification. The lower deck includes primary spaces where crewmembers live and work together: small laboratory areas for carrying out geology and life science research, storage space for samples, airlocks for reaching the surface of planets, and a suiting-up area. We investigated the EuroMoonMars campaign #2 that began on March 7, 2010 and ended on March 20, 2010. The international crew was composed of three French people (FR), an American (US), an Australian (AU) and a Dane (DK). The crewmembers were mixed-gender with three females and three males (n=6), aged between 20 years and 55 years old. We analyzed video recordings made two times over the campaign, on day 2 and day 14, between 18:00 to 20:00. Within this time slot, we chose dinner time because it is a free collective task and it facilitates inter-individual manifestations during daily life activities (Mikolajczak and Tafforin 2013).

The subjects participating in the campaign gave their informed consent.

Quantitative and qualitative descriptions

Figure 2 (see fig. 2) presents behavioral distributions related to the occurrence of interactions (visual interactions + object interactions + body interactions + facial interactions) and the communications (verbal interactions) observed on all the subjects (subjects A + B + C + D + F + G). Comparison between day 2 and day 14 does not show strong differences according to mission time. But the results show that percentages of interactions were higher both on the first day (74%) and the last day (78%) than the percentage of communications (26% and 22% respectively). This difference in the behavioral expressions is significant ($p<0.001$).

As a whole, dominant non-verbal behaviors observed in the multicultural crew may actually be

strategies to compensate differences in language skills. Interaction abilities would be attributed to collective manifestations more largely than communication abilities attributed to individuals. With a different national background of the participants, body language seems to have universal qualities whereas verbal language seems to be specific to nationality.

Figure 3 (see fig. 3)gives details on the quality of interactions during the mission that totalized the days of observations (Day 2 + Day 14) in all subjects (A + B + C + D + F + G). The results show that the total number of visual interactions was at very high level of occurrences (around 700) vs. facial interactions, object interactions and body interactions (under 100) grouped all together. Considering the quality of non-verbal behavior, visual interactions were dominant during the mission compared to the other ones. This dominance is significant ($p<0.001$). Therefore, facial interactions were more frequent than object interactions and body interactions were very few.

Specifically, the multicultural crew seemed to privilege contacts between each crewmember by keeping her/him in one's visual field. As a result, frequent visual interactions occur as if enhancing inter-individual relationships. Crewmembers could build working and living habits according to such common strategies. Positive expressions like smiling or laughing that are included in facial interactions reveal salutogenic effects. Body contacts were not privileged in this isolated and confined environment. It may be a strategy to keep distances between the crewmembers as far as possible.

Figure 4 (see fig. 4) gives other descriptions about the direction of communications over the mission according to each subject (A to G). Data are on dyadic communications, e.g. subject A toward subject B, and also addressed to all of them, e.g. subject A toward the crew. We observed that the total communication length varies from one crewmember to another. Subject A had the lowest level of communication (108 s.) whereas subject F had the highest level (450 s.). The results show that three participants (Subjects D, F and G) were involved in long duration communications between each other and to the crew by using the English language, while the other three participants (Subjects A, B and C) communicated between themselves in French.

English native-language seems to be a facilitating factor in inter-individual communications when English is the common language of international missions. Consequently, crewmembers with these language skills are more communicative in verbal relationships than crewmembers without the same English background. Differences of language skill have an impact on the verbal behaviors. The strategy should be grouping together according to communication abilities.

Figure 5 (see fig. 5) presents profiles of communications and interactions throughout the mission per subject. It supports data on differences of nationality in separating FR, DK and AU/US crewmembers. The results show that the mean duration of communications in subjects A, B and C is short (4 to 5 s.), longer in subject C (9 s.) and at the highest level in subjects F and G (14 s.). This increasing curve is related to increasing language skills.

It appears that similar verbal and non-verbal behavior in French participants that have a common non-native language creates a cultural sub-group that is not used to communicate in English in daily life and thus favors interactions. An individual with a Danish background seems to have balanced communication and interaction abilities. Other individuals with English language skills favor either communication vs. interaction or both communication and interaction. This last behavioral profile is assigned to the crew's commander. A relevant finding is the inversion of occurrences when the

crewmembers' expressions are in their native language switching from dominant interactions to dominant communications.

Figure 6 (see fig. 6a and 6b) helps in visualizing 20-min video recording sequences of the whole verbal and non-verbal behaviors including communications, personal actions, object, body, visual and facial interactions and collateral actions, per subject. In figure (subjects A, B and C) as well as in figure 6b (subjects D, F and G) we observed different events occurring during the collective task at day 14.

The results confirm that the quality of inter-individual relationships is more largely described by visual interactions linked to verbal communications and also depends upon individuals regardless of their nationality. For instance, we observed differences on personal actions with long duration sequences in subject A and frequent short sequences in subject B that switch later to long and frequent visual interactions associated to strong occurrences of collateral acts and facial interactions. There are individual differences within the same cultural sub-group (Figure 6a). Their strategy to compensate English difficulties is to favor interactions in comparison to the multicultural sub-group (Figure 6b) with English better skills favoring communication. As a result, after a 2-week's mission verbal and non-verbal behavioral differences between all the subjects are culture-dependent. Evolving common working and living habits, the former would actively interact, the latter would actively communicate and the whole would be involved diversely in the dynamic process of adaptation.

Discussion

At MDRS, multicultural crews live in isolated and confined environment, work on scientific projects, use robots, perform space walk activities in mock spacesuits, plan and schedule their work with support from scientists and engineers on the Earth, collect their data and write daily reports to inform ground support teams of their progress. In such simulation environment, they are similar to future Martian explorers. As their work is going on, their actions are recorded. When the mission is over, inter-disciplinary communities analyze their unique experience providing useful information to refine crew operations, habitat patterns and behavioral scenarios.

In the present analysis from new combined approaches, we got descriptive results that support our working hypothesis on differences about verbal and non-verbal behaviors according to crewmembers' international background based on communication and interaction abilities. They contribute in a positive way, in term of salutogenesis, to the dynamics process of adaptation by which we may predict new living and working habits and may imagine changes over extended periods of time.

Interactions and communication abilities

In this small space habitat, the methodological tool used in ethology is not only concerned with the result of the behavior, i.e. performances, but also the non-verbal and verbal strategies leading to it, i.e. abilities. We observed, described and quantified strategies to enhance relationships between the crewmembers from their own culture. Quantitative and qualitative descriptions of state events and point events were relevant tools to apply at MDRS during dinner time. Food on the Earth, like aboard ISS, represents a convivial moment to relax and socialize, improving a crew's communication abilities and increasing its well being (Galoforo and Hagemeister, 2016). Rituals like holiday meals were not only the way to learn about life, customs and traditions but they also enhance strong relationships (Polackova Solcova et al., 2016:182) implying both verbal and non-verbal behaviors.

Within a historical framework, non-verbal behavior would be a precursor of verbal behavior. In the phylogenesis, from the first symbols of expression in Neanderthalians, and in the ontogenesis, as the first means of expression in the younger, Sapir (1927) stated that human species responds to gesture in accordance with an elaborate code that is written "nowhere, known by none and understood by all" (cited in Micolajczak, 2010:26). Today, with cultural diversity and exchange possibilities between people with various national background, there are different interactions and communications abilities. This is particular emphasized in our results.

DK, AU and US crewmembers were the participants who communicated over longer durations directed to all the other crewmembers whatever their nationalities, all of them were native English speakers or spoke it fluently. A shared language influences the communication level and has an impact on differences on the interaction level. French speaking crewmembers with a scarce English fluency, interacted longer between themselves. Therefore, the quantity and quality of relationships were different. The first sub-group had either an equilibrated or an accented balance of verbal vs. non-verbal profiles whereas the second sub-group had an inversed balance of non-verbal vs. verbal profiles. These are specific cultural and personal profiles we may expect and would merge in the sharing of a common crew language over time in multicultural adaptive and evolutionary progresses.

Living and working habits

In every culture, there are universal behaviors and established gestures or signs that are equivalent to language codes and expression rules. Nowadays quantitative surveys have listed many distinctive expressions and gestures. These facial mimics and motor acts are regulated by culture and society since their valorization and suppression depends on ethnic group, social context and individual function (Mikolajaczak, 2010:28). In the present study, we showed that personal actions, visual interactions, object interactions and body interactions of a multicultural crew made of French, Danish, Australian and American people, is a combination of different living and working habits. At the individual level, the crewmember with the commander role has an accented and balanced interactive/communicative profile equivalent to his function. At the social level, we found non-verbal and verbal differences in the French sub-group and the Danish-Australian-American sub-group. After two weeks spent together, in a short-term process, such variability and dependability due to multicultural diversity is obvious. The adaptive strategies of each or all crewmembers occurred together with multiple human factors, from elementary parameters (blood pressure, heart rate, immune response, brain activity) to global manifestations (motor behavior, cognitive demand, social relationship, emotional state, national background) (Tafforin, 2009:71). The synergy of all these factors in order to building new living and working habits was not achieved in the studied EuroMoonMars crew.

From an evolutionary perspective, anthropology is useful for surveys on behaviors with biological bases while taking into account the cultural dimension. Culture is associated to a space as well as to a nation. In international missions to the Moon or to Mars, our study promotes some advances in understanding socialization of isolated and confined group far from the Earth. Originally, during the ice ages, *Homo erectus* and *Homo sapiens* were cut off by snow and ice in small camps for long periods of time, hence having to adapt to living in micro-societies. During the interglacial thawing periods, hominids enjoyed meeting with different groups, facilitating genetic crossbreeding and cultural progress (Giner Abati, 1994:144). In the future, with evolving micro-societies in unexplored environments, ethological and anthropological approaches need an ongoing sharpening in several phases of knowledge. The first phase would describe exhaustively adaptive strategies among different cultures. We opened the field in the present study. The second phase should consider selections of

future space explorers by means of their socialization skills taking into account living and working habits related to ethnic differences as well as the new concept of cultural training. The ultimate phase would emphasize the genetic basis of outer space cultures.

To conclude, interdisciplinary projects are driven by the main objectives of the interplanetary voyage to Mars by the end of the 2030s (Viscio et al., 2013:214). Final objectives is planetary colonization. In isolation and confinement, coping with repetitive daily tasks in confined living areas and the working habits of each crewmember, we may imagine the creation of novel habits by the whole crew considered as a micro-society with auto-organization rules. To enhance long-term autonomy of the Martian crew, a scenario could be the development of new interaction and communication abilities by building the same language code and expression rules based on multicultural melting.

Acknowledgments

This research was supported by the French Space Agency (CNES) and the Lunar Exploration Working Group (ILEWG) managed by Pr. Bernard Foing. We thank all the subjects who participated in the EuroMoonMars campaigns.

References

Berry, J.W. (2004). "Psychological of group relations: cultural and social dimensions". *Aviation, Space and Environmental Medicine* 75(7):52-57.

Boyd, J.E., Kanas, N., Gushin, V.I., Saylor, S. (2007). "Cultural differences in patterns of mood states on board the International Space Station". *Acta Astronautica* 61:668-671.

Douglas, A.V. (2011). *Psychology of space Exploration*. NASA SP-2011-4411. Washington. NASA History Series.

Draguns, J.G., Harrison, A.A. (2011). "Spaceflight and cross-cultural psychology". In *Psychology of space Exploration*, edited by Douglas A. Vakoch, NASA SP-2011-4411, pp. 195-204. Washington. NASA History Series.

Etienne, J.L. (1990). *Transantarctica: la traversée du dernier continent*. Paris: Laffont.

Feichtinger, M., Sundbal, P., Zell, M., Urbina, D., Charles, R., Kuipers, A. (2012). "The role of communication for psychological crew support during human exploration mission simulation Mars-500". Paper IAC-12,A1.1.24 presented at the 63th International Astronautical Congress, Naples, Italy, 1-5 October.

Galoforo, G, Hagemeister, D. (2016). "Social dynamics and psychological wellbeing on ISS. Technologies, devices, behaviors". Paper IAC-16-A1.1.7 presented at the 67th International Astronautical Congress, Guadalajara, Mexico, 26-30 September.

Giner Abati, F. (1992). *Los Himba*. Salamanca: Amaru Ediciones.

Giner Abati, F. (1994). "Raices Biológicas del Comportamiento Humano y de la Cultura (Etología Humana)". In *Antropología*, edited by C.P. Kottak. Madrid, Spain: Mc Graw-Hill.

Giner Abati, F. (1995). "Etnografía en una Comunidad Primitiva". In *Etnografía*, edited by A. Aguirre. Barcelona, Boixareu.

Gourinat, Y., Apel, U., Delbart, F. (2010). "The Aerocrew mission : training space session at Ny Alesund Arctic base". *Acta Astronautica* 66:74-77.

Gushin, V.I., Pustynnikova, J.M., & Smirnova, T.M. (2001). Interrelations between the small isolated groups with homogeneous and heterogeneous composition. *Journal of Human Performance in Extreme Environments, 6*(1), 26-33.

Gushin, V.I., Shved, D., Vinokhodova, A., Vasylieva, G., Nitchiporuk, I. (2012). "Some psychophysiological and behavioral aspects of adaptation to simulated autonomous mission to Mars". *Acta Astronautica* 70:52-57.

Hall, E.T. (1971). *La dimension cachée. The hidden dimension*. Paris, France: Seuil.

Kanas, N. (2015). *Humans in Space*. Switzerland: Springer.

Kanas, N. (2016). "Mission to Mars: the psychological hurdles". Paper IAC-16-A1.1.6 presented at the 67th International Astronautical Congress, Guadalajara, Mexico, 26-30 September.

Kanas, N., Sandal, G.M., Boyd, J.E., Gushin, V.I., Manzey, D., North, R., Leon, G.R., Suedfled, P., Bishop, S., Fiedler, E.R., Inoue, N., Johannes, B., Kealey, D.J., Kraft, N., Matsuzaki, I., Musson, D., Plinkas, L.A., Sanistskiy, V.P., Sipes, W., Stuster, J., Wang, J. (2009). "Psychology and culture during long-duration space missions". *Acta Astronautica* 64:659-677.

Kanas, N., Saylor, S., Harris M. Neylan, T., Boyd, J., Weiss, D.S., Baskin, P., Cook, C., Marmar, C. (2010). "High versus low crewmember autonomy in space simulation environments". *Acta Astronautica* 67(7):731-8.

Kokot, W. (2007). "Culture and space: anthropological approaches". *Ethnoscripts* 9(1):10-23.

Kraft, N.O., Lyons, T.J, and Binder, H. (2003). "Intercultural crew issues in long-duration spaceflight". *Aviation, Space and Environmental Medicine* 74(5):575-8.

Leersnyder (De), J., Mesquita, B., Kim, H., Eom, K., and Choi, H. (2014). "Emotional fit with culture: a predictor of individual differences in relational well-being". *Emotion* 14(2): 241-5.

Love, S.G., Bleacher, J.E. (2013). "Crew roles and interactions in scientific space exploration". *Acta Astronautica* 90:318-31.

Mikolajczak, M. (2010). "Verbal and non-verbal communications in space: a confined and isolated environment". In *Report supervised by B. Foing (ILEWEG)*. Leiden, Netherlands.

Mikolajczak, M. Tafforin, C. (2010). "Verbal and non-verbal communications. EuroMoonMars Campaign at the Mars Desert Research Station". International Astronautic Federation (IAF) - Global Lunar Conference, Beijing, Japan, 31 May-3 June.

Palinkas, L.A., Suedfeld, P. (2008). "Psychological effects of polar expeditions". *The Lancet* 371:153-63.

Polackova Solcova, I., Solocova, I., Stuchlikova, I., Mazehoova, Y. (2016). "The story of 520 days on a simulated flight to Mars". *Acta Astronautica* 126:178-189.

Ritsher, J.B., Ihle, E.C., Kanas, N.A. (2005). "Positive psychological effects of space missions". *Acta Astronautica* 57:630-633.

Ritsher, J.B., Kanas N.A., Ihle, E.C., Saylor, S.A. (2007). "Psychological adaptation and salutogenesis in space: lessons from a series of studies". *Acta Astronautica* 60:336-340.

Suedfeld, P. (2001). "Groups in special environments". In *International Encyclopedia of Social & Behavioral Sciences*. New York: Elsevier.

Suedfeld, P. (2005). "Invulnerability, coping, salutogenesis, integration; four phases of space psychology". *Aviation, Space and Environmental Medicine* 76(6):61-66.

Suedfeld, P., Brcic, J. (2011). "Resolution of psychosocial crises associated with flying in space". *Acta Astronautica* 69:24-29.

Suedfeld, P., Steel, G.D. (2000). "The environmental psychology of capsule habitats". *Annual Revue of Psychology* 51:227-253.

Sandal, G.M., Bye, H.H., Vijver (Van de), F.J.R. (2013). "The risk of groupthink during long-duration space missions: results from a 105-day confinement study". In *On orbit and beyond: psychological perspectives on human spaceflight*. pp. 135-148. Berlin, Germany: Springer.

Sandal, G.M., Manzey, D. (2009). "Cross-cultural issues in space operations: a survey study among ground personnel of the European Space Agency". *Acta Astronautica* 65:1520-9.

Sarris, A. (2006). "Personality, culture fit, and job outcomes on Australian Antarctic stations". *Environment and Behavior* 38(3):356-372.

Tafforin, C. (1999). "Human Ethology in Extreme Settings: from the individual in orbital flight to a small group in polar base". *Human Ethology Bulletin* 14(1): 5-7.

Tafforin, C. (2005). "Ethological indicators of isolated and confined teams in the perspective of Mars missions". *Aviation, Space and Environmental Medicine* 76:1083-1087.

Tafforin, C. (2009). "Life at the Franco-Italian Concordia station in Antarctica for a voyage to Mars: Ethological study and anthropological perspectives". *Antrocom.* 5(1):67-72.

Tafforin, C. (2013a). "The Mars-500 crew in daily life activities: an ethological study". *Acta Astronautica* 91:69-76.

Tafforin, C. (2013b). "Time effects, cultural influences and individual differences in crew behavior during the Mars-500 experiment". *Aviation, Space and Environmental Medicine* 84(10):1082-6.

Tafforin, C. (2015a). "Global ethological analysis of crew's adaptive dynamcis in extreme settings for future human planet exploration". 9th IAA Symposium on the future of space exploration: towards new global programmes, Turino, Italy, 7-9 July.

Tafforin, C. (2015b). «Comparison of spatial-temporal adaptive indicators in isolated and confined teams during the Concordia stay, Tara drift and MARS-500 experiment». *Journal of Human Performance in Extreme Environments*, 12(1) <http://dx.doi.org/10.7771/2327-2937.1062> accessed 20 May 2005.

Tafforin, C. (2015c). "Confinement vs. isolation as analogue environments for Mars missions from a human ethology viewpoint". *Aerospace Medicine and Human Performance* 86(2):131-135.

Tafforin, C., Gerebtzoff, D. (2010). "A software-based solution for research in space ethology." *Aviation, Space and Environmental Medicine* 81:951-956.

Tafforin, C., Giner Abati, F. (2016). "Cultural ethology as a new approach of interplanetary crews's behavior". Paper IAC-16-A1.1.3,x32403 presented at the 67th International Astronautical Congress, Guadalajara, Mexico, 26-30 September.

Urbina, D.A., Charles, R. (2014). "Symposium keynote: enduring the isolation of interplanetary travel". A personal account of the Mars500 mission". *Acta Astronautica* 93:374-383.

Ursin, H., Etienne, J.L., Collet J. (1990). "An Antarctic crossing as an analogue for long-term manned spaceflight". *ESA Bulletin* 64:45-49.

Viscio, M.A., Gargioli, E., Hoffman, J.A., Maggiore, P., Messidoro, A., Viola, N. (2013). "A methodology to support strategic decisions in future human space exploration: from scenario definition to building blocks assessment". *Acta Astronautica* 91:1998-2017.

Week, E., Ashkar, C. (2016). "Intercultural competence: behavior, performance and psychosocial considerations". Paper IAC-16-A1IP,25,x34743 presented at the 67th International Astronautical Congress, Guadalajara, Mexico, 26-30 September.

Wu, R., Wang, Y. (2015). "Psychosocial interaction during a 105-day isolated mission in Lunar Palace 1". *Acta Astronautica* 113: 1-7.

Figure 1. Video cameras positions inside MDRS in the living area of the upper desk.

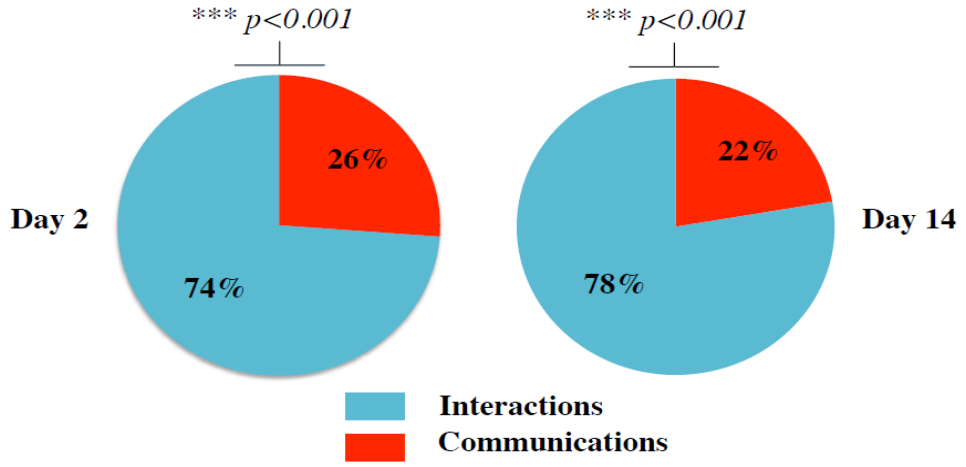

Figure 2. Global non-verbal and verbal behavior (interactions and communications) in percentage (summed subjects) per day of mission at MDRS.

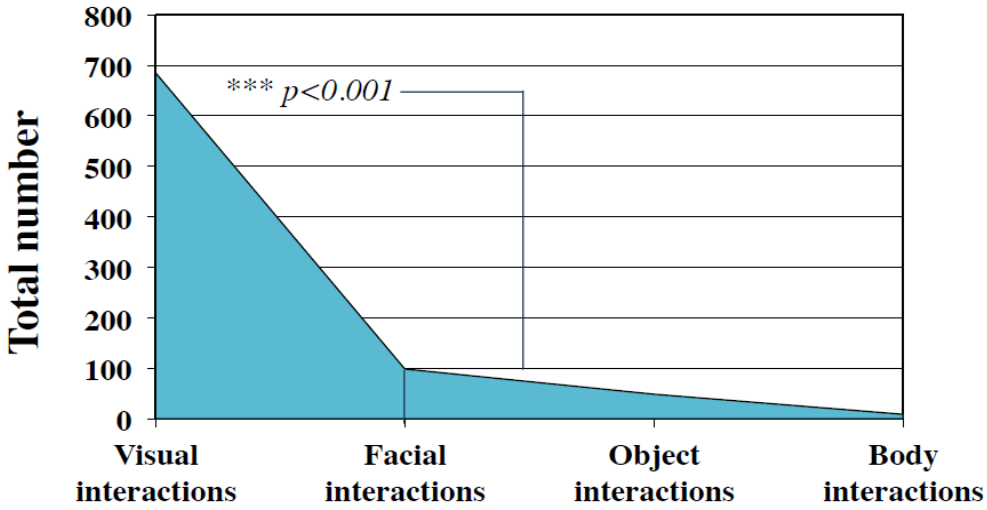

Figure 3. Quality of interactions in total number (summed subjects) over the mission at MDRS.

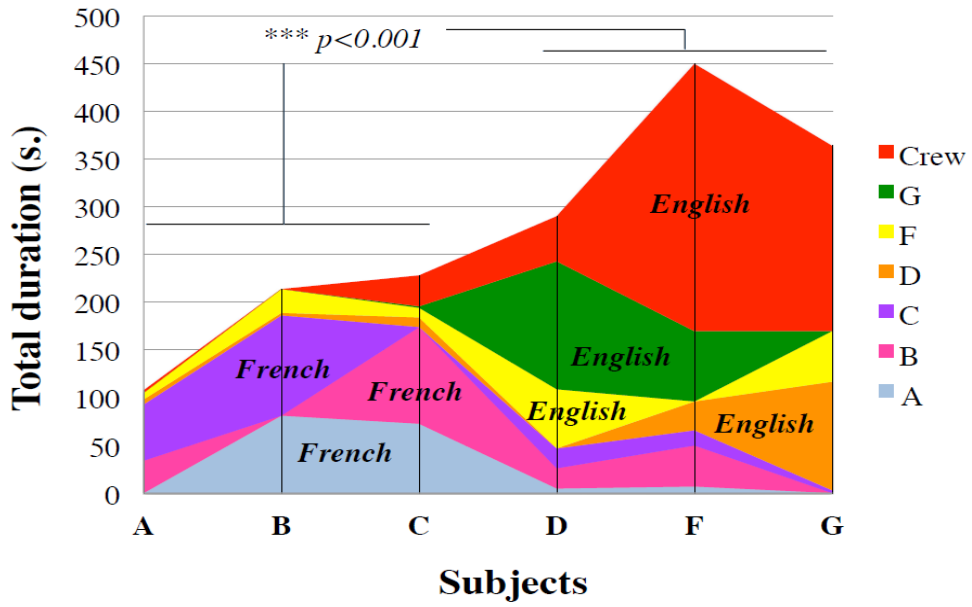

Figure 4. Direction of communications (towards subjects) in total duration (s.) per subject over the mission at MDRS. English and French are related to language skills.

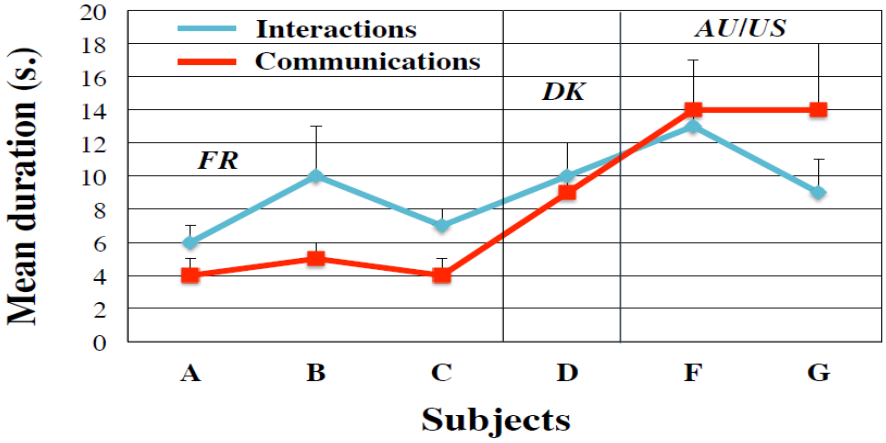

Figure 5. Communications and interactions as mean duration (s.) per subject over the mission at MDRS.

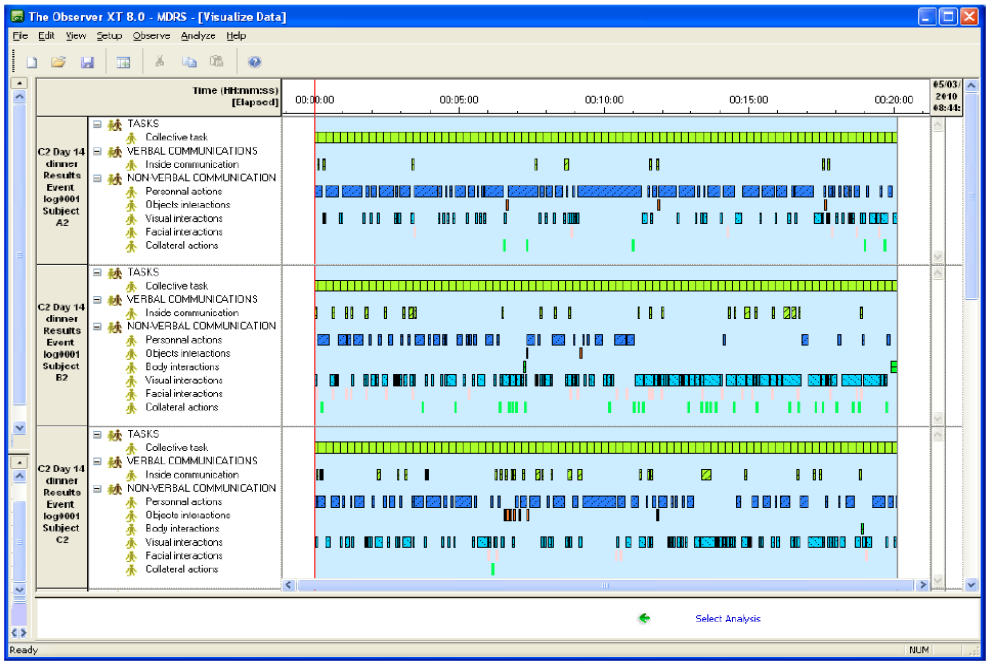

Figure 6a. Visualized sequence of non-verbal and verbal behavioral abilities in subjects A, B and C on the last day of mission at MDRS.

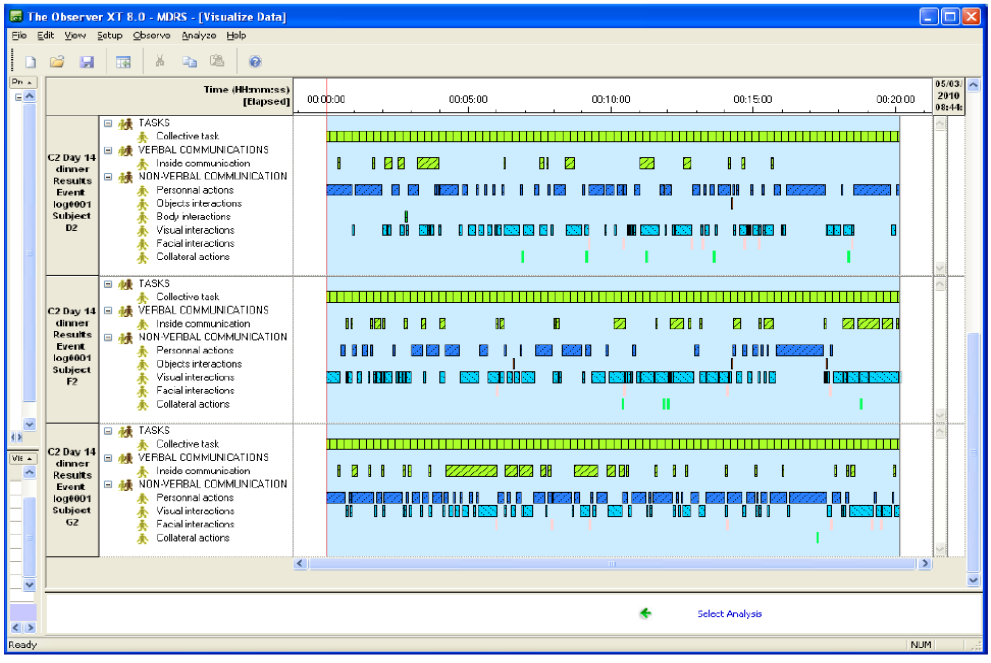

Figure 6b. Visualized sequence of non-verbal and verbal behavioral abilities in subjects D, F and G on the last day of mission at MDRS.