



## Behaviors of a mixed gender and culture group during a 4-month confinement (SIRIUS-19)

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### KEYWORDS

Human ethology; space flight; adaptation; interactions; communications; diversity

### ABSTRACT

*With a view to prepare human groups for long international and interplanetary missions, Scientific International Research in Unique Terrestrial Station (SIRIUS) program develops confinement campaigns whose SIRIUS-19 was 4-month duration. The goal was to simulate four phases of a mission including traveling to the Moon, orbiting the Moon, landing on the Moon, and returning to Earth. The Russian-American crew (n=6) consisted in 3 females and 3 males subjects. The ethological method for non-verbal and verbal behaviors analysis was based on observation, description and quantification of spontaneous actions, interactions, expressions and positions at meal time twice a month, and during group discussion, once a month. Results show expressive and communicative behaviors in female subjects, and less active but more interactive behaviors in male subjects, with specific adaptive strategies built by each ones. Crew cohesion follows a temporal dynamics. Discussion is on personal value and diversity value that contribute to the heterogeneous quality of a mixed gender and culture group in a positive way for space exploration success.*

### Introduction

Men and women live on Earth as a global human community. At the mature age, they are equally distributed. The distribution varies upon culture as countries and ethnicities mitigate births and favor either boys or girls. Thus, the quantity of females and males in this broad group is not equal. The quality of a mixed gender group is what we are interested in the present paper, as a beneficial mixture of mankind expressed by their own behaviors. Concomitantly, the multinational nature of group-members based on their cultural habits reinforces this diversity value. Each individual with personal value contributes to this salutogenesis (Ritsher et al., 2007:336; Suedfeld and Brcic 2011:24), i.e. positive impacts on well-being in daily life activities.

Far from Earth, in the future planetary explorations, human behavioral adaptation at the level of the individual and at the level of the group, will be the goal of self-organized and remote micro-societies in isolated and confined environments (Tafforin, 2009a:67; Tafforin, 2018:31). A manned mission to Mars is an exceptional opportunity to highlight biomedical issues (Orlov et al., 2014:182) and psychological issues (Kanas et al., 2009:661) of men and women under particular sensory-motor conditions and socio-cultural conditions in extended periods of time. The ethological approach, science of behavior, is particularly concerned with the interface. In these unusual living and working situations, it supports anthropological perspectives and provides qualitative and quantitative methods.

They were applied to a wide panel of extreme conditions such as the American space shuttle flights and the Russian orbital Mir station (Tafforin, 1994:137), the Chinese Controlled Environmental and life support system experiment (Tafforin et al., 2019:486), the French-Italian Concordia polar base in Antarctica (Tafforin, 2009b:12), the European campaigns of confinements (Tafforin, 2005:1085), the French Tara-expedition in Arctic (Tafforin, 2011:110) and the Russian Mars-500 experiment (Tafforin, 2013:70) involving national, bi-national and multi-national crews. The whole ethological results showed what we could summarize in terms of *3R-adaptation* that implies Referentials, Rhythms and Rituals. An astronaut develops motor adaptive strategies by using new possibilities of up-down body orientations in visual cuing as referentials vs. gravitational referential missing (Tafforin and Campan, 1994:415). During long duration periods of isolation inside the polar bases, winterers build social adaptive strategies by breaking up the rhythm of collective time. It increases following cyclic variations to cope with monotony (Tafforin, 2015:268). During the 520-day confinement simulating an interplanetary voyage to Mars, the Marsionauts build personal adaptive strategies at mealtime. Their interaction profiles change according to the crewmembers with their own rules for living, working habits, specific customs and daily rituals (Tafforin and Giner Abati, 2017:109).

We emphasized behavioral changes within a multicultural crew during a 15-day confinement at the Mars Desert Research Station (MDRS) in Utah-USA. The focus was on interaction and communication abilities according to nationalities (French, Danish, Australian and American). The results showed global high occurrences of visual interactions compared to both facial, body and object interactions. Discussion from anthropological perspectives was on differences of language skill impacting communication abilities. Subjects using no-native languages compensate with interaction abilities. Evolving to common working and living habits, the ones actively interacted, the other ones actively communicated and the whole was involved in positive behavioral adaptations with cultural diversity (Tafforin and Giner Abati, 2016:97). To support such findings, our new investigation is to analyze the impact of mixed gender group to such process. With the challenge of space exploration that may be short trips on the Moon, a long trip to Mars or planets colonization, the scope of the present paper is to enrich knowledge on human behaviors in analogue environments and simulated conditions of micro-societies as autonomous and auto-organized systems far from any terrestrial civilizations.

Our general hypothesis is about personal value and diversity value that contribute to the heterogeneous quality of a mixed gender and culture group whose specificities of behaviors are major factors of positive adaptations for missions success.

In the history of space travelers, although the first woman performed an orbital flight in 1963, very early in crewed space exploration, it would not be until almost twenty years later that another woman flew. In 2020, we count 65 female astronauts vs. 500 male astronauts. Beyond the size of the group, and the mixture of cultural and ethnic backgrounds, the most salient crew composition variable is gender (Kring & Kaminski, 2011:125). Knowledge of the influences of such variable requires further investigations. A review of women's health and adaptation to space points out gender-based differences in the areas of cardiovascular, immunological, sensory-motor, musculo-skeletal, reproductive and behavioral changes that occur during spaceflight (Mark et al., 2014:1-12). The present ethological investigation deals with this last point that needs further advances and continued sharpening from multidisciplinary approaches. For instance, in psycho-physiological investigations aboard International Space Station (ISS), analysis of astronauts' neurobiological and sleep measures showed no gender differences in alertness using the Psychomotor Vigilance Test (Basner et al., 2011:949). While women are more stress reactive on Earth (Goel et al., 2014:984), little research has

examined whether the specific types of stressors found in space show similar tendency. However, we could find evidence of pattern of emotionality but the complexity of evaluating subjective responses is not fully resolved (Alfano et al., 2018:296) in the wide panel of emotion-based scales. Objective methods used in our study provide objective solutions. Because all selected astronauts undergo a strong process of psychological screening, physical strengthening, operational training, motivational maintaining thus, mood, anxiety, depression both in males and females may be reduced. Women can sometimes improve group climate (Kanas, 2015:41).

The longest stay performed by a woman aboard ISS was recently achieved. She landed on Earth after 328 days spent in orbit. Future space missions have new challenges to solve that are autonomy in a closed environment (Gushin et al., 2012:52; Goemaere et al., 2019:274) and monotony due to long-duration travels (Peldszus et al., 2014:263). As a result, individual's well-being and group spirit will be of prime importance on how well he and she will adapt to the demands of confinement in synergy with time.

Arctic and Antarctic missions involve more mixed-gender teams. Including women in a wintering group seems to have positive effects on the general climate of the group by reducing men's rude behavior (Rosnet et al., 2004:10). Women added an element of emotional support and helped other members. This pattern is not as evident in all-male groups (Leon and Sandal, 2003:259). On one hand, all-male teams exhibited higher levels of competitiveness and fewer tendencies to talk about their feelings during polar missions (Leon, 2005:84). On the other hand, in a two-woman traverse of Antarctica, advantages of the co-equal dyad were evident in the cooperative nature of the decision-making and substantial similarities to solve problems (Atliset al., 2004:403). All-female teams were rare until recently. In all-women expeditions, group climate and individual functioning would be more sensitive to emotional concerns (Kahn & Leon, 2000:35). Regarding status differences, female leaders reported receiving substantially less social support female followers in Antarctic expeditions (Schmidt et al., 2005:928). This provides evidence of the heterogeneous quality of a group to cope, regulate, and adapt itself for better behavioral health in isolated and confined conditions. In these terrestrial analogs like spatial conditions, group's composition is a key diversity. We assume that it plays a significant role in the interactions within the space crew.

Our working hypotheses are on the occurrences of different non-verbal and verbal behaviors between males and females, and diverse adaptive strategies within the mixed gender and culture group in social constraints and spatial restrictions during a 4-month confinement. We propose the ethological approach that is the study of behavioral expressions from the optimal relationship between the individual and its environment. The operational definition of behavior is the emergence «here» and «now» of a systemic (notion of globalism) and historical (notion of continuity) process that can be qualified and quantified (notion of objectivity) according to non-invasive methods (Campan, 1980:1-258).

## **Methods**

### *Confinement campaign*

With a view to prepare human groups for long international and interplanetary missions, Scientific International Research in Unique Terrestrial Station (SIRIUS) is a multiannual confinements program in progress. SIRIUS is jointly operated by the Institute for Biomedical Problems (IBMP) of the Russian

Academy of Sciences and NASA's Human Research Program (HRP). In the framework of behavioral analyses, an ethological integrated study was performed during a 4-month confinement campaign. It began on Mars 19, 2019, ended on July 17, 2019, and was named SIRIUS-19. The environmental conditions and experimental facilities are the same than Mars-500 experiment that took place in Moscow, Russia (Urbina and Charles, 2014:376). They were structured as four hermetically sealed, interconnected modules. Warehouse, scientific and sport equipment, shower, toilet and greenhouse are in a module. Crew quarters, living room, kitchen and toilet are in another module. A medical module is dedicated to blood sampling, electrocardiogram tests, docking with space station and moon rover simulators. The Moon surface module is only opened to simulate cargo ships and moon lander.

The scenario dictated reproduction of the basic analog features owing to which the crew felt like they were on a real mission and dismissed from their minds the life outside the modules. They simulated a Moon mission. Every event inspired the crew to group-work. The main goal was the choice of the area for future construction of a settlement on a lunar surface. Moon mission milestones were:

- Start for Moon. The crew arrives to the lunar orbit and docks to an orbital station (a deep space Gateway analog);
- Over a 2-month period the crew conducts observations and decides where to land and perform several (usually night) docks with transport vehicles;
- Four crewmembers land to the Moon and perform four extra-vehicular activities (EVA). Meanwhile, the orbiting vehicle and the last two crewmembers continue orbiting and provide technical assistance and advice to those on the lunar surface;
- Departure from the moon and dock with the orbiter.
- Orbiting the Moon over several weeks in order to operate rovers remotely and to receive transport vehicles that dock usually at nighttime.
- Return to Earth.

The mixed gender crew was equally distributed in three females and three males and consisted in four Russians and two Americans (n=6). The oldest was 44 years. Their functions during the experiment were one commander, one flight engineer, one crew physician and three researchers. They were selected based on their career experience, skills and personality to gauge their suitability for the program. The subjects participating in the SIRIUS-19 campaign provided her/his informed consents.

Over a 24-hour living and working day, the crew had 16 hours waking period including 8 hours as working day with 80 experiments to run and a multitude of psychological and physiological exams to conduct. The immersive EVA experience where astronauts walked on the Moon, worked with scientific equipment, chipped away the pieces of moon rock and repaired rover, lasted 1 hour each. The rest was considered as free time that could also be used for operational tasks or science activities but also as collective time for meals taken together every day. Meals were planned to mimic the packaged meals that are a staple on the ISS and likely on future deep space exploration. That was the situation of observations for our study.

### *Methodological tools*

The ethological method for behaviors' analysis uses three tools: 1-observation, 2-description and 3-quantification of spontaneous actions, interactions, expressions and positions in daily life activities or

specific tasks. The goal is to explore the field of observable events that is complementary to physiological investigations, psychological tests and anthropological technics. The advanced logistic support is the subjects' video recording collected with four safety cameras intersecting the total observational area of the dining room completed with one fisheye camera. Twice a month, video recordings were performed at breakfast (BF), in the kitchen of the habitat module. The analyzed mission days (MD) are nine temporal points (MD5, MD20, MD34, MD48, MD62, MD76, MD89, MD118, MD132). We analyzed various 15- to 30-minute time slots while subjects are in sitting position (s) around the BF table. Once a month, video recordings were performed during a collective task, the group discussion (GD), from the same cameras set. We analyzed equal duration recordings (15 minutes) over four temporal points (MD17, MD48, MD101, MD128) when subjects start speaking after a reading period about the topic of the day.

The observational data during BF focused on (p) personal actions (any body segment movements, postural changes), (v) visual interactions (any regards directed to one subject), (b) body interactions (any body contacts between two subjects), (m) body mobility (any position modifications), (o) object interactions (any manipulations from one subject to the other one), (f) facial expressions (any face movements such as smiling, laughing) and (c) collateral acts (any small movements with no manifested functions such as scratching the head, scratching the noise), (e) body expressions (any body segments movements as body language). Items (p), (v), (b), (m), (o) are state events (temporal). Items (f), (c), (e) are point events (factual). The observational data during GD focused on verbal interactions (communications of one subject to subject Female 1, Female 2, Female 3, Male 1, Male 2, Male 3, or to all subjects) or (0) no verbal interaction. The whole items are state events.

Non-verbal and verbal behaviors of each subject was then scored with The Observer XT® 14.0 (Tafforin, 2017:5). It is a software-based solution for collecting, organizing and processing observational data from synchronized video files. Qualitative analysis results from observation and description steps. Quantitative analysis results from non-parametric descriptive statistics provided in the software that automatically scored the events in frequency of occurrences (relative and absolute) and durations.

## Results

### *Non-verbal behaviors*

Living and working in confinement is punctuated by social activities and individual tasks. Meals are periodic meetings in the collective area of the habitat. On morning, day-to-day breakfast give the possibility to spend time together as a group. It is a relevant situation for observing, describing and quantifying spontaneous non-verbal behaviors.

Figure 1 presents the behavioral flow in acts per minute of the total non-verbal behaviors (personal actions + visual interactions + object interactions + body interactions + body mobility + facial expressions + collateral actions + body expressions) in the mixed-gender group, during SIRIUS-19 campaign. The results show a significant difference ( $p < 0.001$ ) between females with higher level (7 acts/min) and males with lower level (6 acts/min). Globally, the non-verbal behaviors' occurrence is gender-dependent with different activity levels. This quantitative analysis gives first indications of adaptive strategies with specific profiles. Female subjects are more active than male subjects. Any actions, interactions and expressions are more frequent during the same collective time. We could interpret such manifestations as a stronger involvement in group's life.

Figure 2 presents the behavioral categories of the mixed-gender group in relative occurrences (%). The distribution in females is respectively, facial expressions (28%), personal actions (25%), visual interactions (23%), body expressions (10%), collateral actions (8%), object interactions (4%), body expressions (1%) and body mobility (1%), during total SIRIUS-19 days. The distribution in males is personal actions (30%), visual interactions (26%), facial expressions (19%), collateral acts (10%), body expressions (8%), object interactions (5%), body expressions (1%) and body mobility (1%), during SIRIUS-19 campaign. In each sub-group the differences of percentage are significant ( $p < 0.0001$ ). The results show varied distributions between females and males. Comparatively, the behavioral profiles are different. Primary trends emerge alike but secondary trends define specific profiles. For instance, the three main categories of personal actions, visual interactions and facial expressions are common behaviors. But their occurrences do not follow the same distribution. The qualitative analysis supports the global results from the quantitative analysis and points out specifications of observed behaviors. In females, facial expressions are at the highest level vs. personal actions in males. Female subjects are more expressive than male subjects whereas male subjects are more interactive than female subjects. Collateral actions that have not obvious functions in the current task are slightly more frequent in males than in females. Few manipulations made together are observed. Body contacts are not privileged whether they are female or male. It may be a way to keep inter-personal distances in confinement. The involvement in group's life follows these related activities.

Figure 3 presents positive vs. negative non-verbal expressions in the mixed-gender group in absolute occurrences (total number during SIRIUS-19 campaign). The results show significant differences. The highest level (1264) is on facial expressions in female subjects compared to the level (826) in male subjects ( $p < 0.001$ ). The lower level (361) is on collateral actions in female subjects compared to the level (453) of male subjects ( $p < 0.01$ ). Facial expressions, such as smiling and laughing, are positive manifestations as they are indicators of well-being. Collateral actions, such as scratching the head or scratching the noise, are negative manifestations as they are indicators of stress or discordance between the individual and its environment. This supports the global behavioral data with specific profiles. Males' interactive behavior could be source of stress in relationships between the crewmembers. Females' expressive behavior could be source of salutogenic involvement in group's life.

Figure 4 presents the behavioral dynamics according to time (MD) of the whole non-verbal interactions in mean duration (seconds according SIRIUS-19 days). The mixed-gender group follows same variations over the mission days. We observed longer durations of non-verbal interactions at the beginning of confinement (MD5). Shorter durations are after mi-period (MD76) then the curve slightly increases to the last day (MD132). Curves are tight but at under levels in male subjects compared to female subjects. As a result, males are involved more frequently in the interactions but on shorter durations compared to females. In the process of adaptation, we could interpret such varied non-verbal interactions as diverse behavioral strategies within the mixed-gender group as a whole. Group cohesion is observed day after day following same dynamics over 4-month confinement.

### *Verbal behaviors*

Group discussions were proposed to the crew as a standardized task based on collective topics allowing to express viewpoints and to answer questions. It is a relevant situation for observing, describing and quantifying verbal behaviors.

Figure 5 presents communications in the mixed-gender group, in absolute occurrence (total number during SIRIUS-19 campaign). The picture draws levels of verbal interactions from female subjects (female 1, female 2, female 3) and male subjects (male 1, male 2, male 3) to each ones. The results show the highest levels of communications (violet area: 30 to 40) within the females' sub-group. High levels are also within the males' sub-group (green area: 20 to 30). Some verbal interactions occur individually as for instance from male 1 to female 2 and from female 2 to male 1 (red areas: 10 to 20). Verbal behaviors seem to occur upon gender-preference. We could interpret such manifestations as behavioral profiles whose specificities are based on common personal traits in females, on one side, and on common personal traits in males, on the other side.

Figure 6 presents communications in the mixed-culture males sub-group, in mean durations (seconds during SIRIUS-19 campaign). The results show longer verbal interactions (3 seconds) between American subjects compared to the level between American subjects and the Russian one (2 seconds). We do not present data in females as they are all Russian subjects. Verbal behavior's durations seem to be cultural-dependent in males. There may be differences in language skills or lifestyle habits that bring together crewmembers and that influence the group's communication as a whole.

Figure 7 presents communications towards the crew per gender and culture in absolute occurrences (total number during SIRIUS-19 campaign). The results show diverse verbal interactions to all subjects whether they are male or female, and Russian or American. The differences between subjects are significant ( $p < 0.001$ ). Russian female 3 have the highest level of occurrences (70 to 80) and American male 2 have the lowest level (20 to 30). Other levels of verbal interactions to all respectively decrease in Russian female 3 (60 to 70) and Russian male 1 (60 to 70), in Russian female 1 (50 to 60) towards American male 3 (40 to 30). This points out personal non-verbal behaviors based on individual qualities, language abilities and common specificities. The whole female subjects are involved in more communications than male subjects during group discussions.

Figure 8 presents communications dynamics within the mixed-gender group, in mean durations (seconds) according Mission Days. The results show a decrease of verbal interactions in females from MD17, MD48, MD101 to MD128 with significant linear correlation ( $p < 0.001$ ). The decreasing linear trend is less significant in males ( $p < 0.01$ ). We observed the longest durations after a 7-week period (MD48) in both gender sub-groups (6 seconds) and the shortest durations at the end of confinement (MD128) also in both gender sub-groups (3 seconds). There are different levels between females and males at MD17 and MD101. Variations in the temporal process of adaptation are behavioral strategies built by the crewmembers to break up the monotonous living and working activities. Sometimes, they individually vary their behaviors, sometime they collectively vary their behaviors. As a result, we underlie periodic changes over the 4-month confinement.

## Discussion

Collective area and collective time with collective attendance of the whole group-members give a relevant situation of observations regarding 3R-adaptation. The dining-room is a spatial referential. The schedule of meals is a temporal rhythm given to the group every morning. To start the day, breakfast is a ritual where meal ingredients are the same, gestures to prepare it are repeated and tastes are shared. Some subjects have a cup of coffee together, others prefer a cup of tea. Still others have their own eating habits. They thus adapt to the unusual situation of confinement conditions through

usual behaviors. Behavioral strategies however vary within the mixed-gender and culture group in a way to optimize the relationship between the individual and its environment. It is an ethological point of view. We do not study the performance. We study the motor patterns leading to it, that is to say the behavioral strategies. There are not good or bad behaviors. The results show the quality and the quantity of individual differences. They are optimal behaviors according to each person with personal value and following group cohesion with diversity value.

### *Personal value*

In previous experiences, psychologists have studied the extend to which confined crewmembers perceive increasing convergence in personal values and whether they attribute less tension to individual differences over time (Sandal et al., 2011:144). Analyses are on subjective evaluations based on perceived differences. They suggest that personal values should be considered in composition of crews for long duration mission like a mission to Mars. In our qualitative and quantitative analysis we made objective observations of actions, interactions, expressions, positions and communications that occur from the crewmembers' perception while living and working in confinement conditions.

We observed that behavioral flow totalizing the whole behaviors of a group composed of female and male subjects, is gender-dependent with different activity levels. Comparison of non-verbal behaviors shows differences of occurrences. That supports our first working hypothesis. We also observed specific profiles with interactive behaviors in males and expressive behaviors in females. The first ones are more frequently involved in the interactions but of short durations compared to females. The last ones are more frequently in positive vs. negative manifestations such as facial expressions. Diverse adaptive strategies are thus built by the crewmembers. That supports our second working hypothesis.

The personal value of self-direction characterized by being independent, creative, having a desire to explore, emerges as a priority value (Smith and al., 2017:142). With the same mission goal of space exploration simulated during SIRIUS-19 campaign, each subject behaves independently as they are more or less involved in personal actions or interpersonal actions. This is marked in non-verbal and verbal behaviors. We observed that some verbal interactions occur individually from one male to one female and conversely but we also observed varied non-verbal interactions as diverse behavioral profiles within the mixed-gender group. Specificities are based on common personal traits in females, on one side, and on common personal traits in males, on the other side.

### *Diversity value*

Experiences from long-duration confinements suggest that monotony induced by low workload can have interpersonal effects on the working group's performance (Sandal & Bye, 2015:171). Boredom generated by low diversity of collective activities can have also adverse implications on the group's live involvement. In our analysis, observational data from mealtime and group discussion give an overview on how the crew develops varied behaviors against monotonous rhythm of daily life activities.

According to Anzieu and Martin (1986), a group is a dynamic organization where all the forces are in equilibrium and regulated to obtain an optimal efficiency of the team's behavior. The rules of specific adaptation of an isolated and confined crew could thus be compared to the laws governing self-organizing systems. These laws are conducted upon heterogeneity of their own elements and confer diversity value as a result. A mixed-gender and culture group has such special characteristics

and the behaviors that emerge have specific qualities. Crewmembers with their individual differences, their gender identity and their own culture, positively adapt to confinement conditions in the way to optimize their relationship with his/her environment. Such individualities are observed from diverse verbal interactions to all subjects whether they are male or female, and Russian or American.

Time effects can influence cohesion in confined and isolated groups as it was found on a lunar space station analogue in agreement with those obtained from Mir station and from ISS (Wang and Wu, 2015:819). Over 4-month confinement, we observed common behaviors from the general distribution of behavioral categories. Major ones that define qualitative primary trends are personal actions, visual interactions and facial expressions. Nevertheless, quantitative levels are different whether they occur in females or males. This defines the second trends of specific profiles upon diverse non-verbal and verbal behaviors occurrences. It is specifically emphasized in verbal interactions whose durations could be culture-dependent in males. Heterogeneity of the group characterized by differences in language skills or lifestyle habits bring together each subject of the group and influence the group's communication as a whole. From this diversity value, crew cohesion is building and follows temporal dynamics. At the same day, we observed same behaviors in all subjects. The focus is after one-month confinement as if they increased durations of communication between them for enhancing their autonomy far from any contacts with Earth and for breaking up monotony over time. At the end of 4-month confinement, they decreased communications again together as being an entity.

We see that personal value and diversity value could be combined as actions, interactions, expressions and communications vary according to subjects and mission days.

To conclude, expressive and communicative behaviors in female subjects, less active but more interactive behaviors in male subjects, with specific adaptive strategies built by each ones over time are the general features to emphasize. We expect salutogenic impacts of frequent facial expressions in females to mitigate collateral actions in males for optimizing the group's live involvement during long duration confinements. It is in accordance with our general hypothesis about personal value and diversity value that contribute to the heterogeneous quality of a mixed gender and cultural group whose specificities of behaviors are major factors of positive adaptation for space exploration success.

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Images

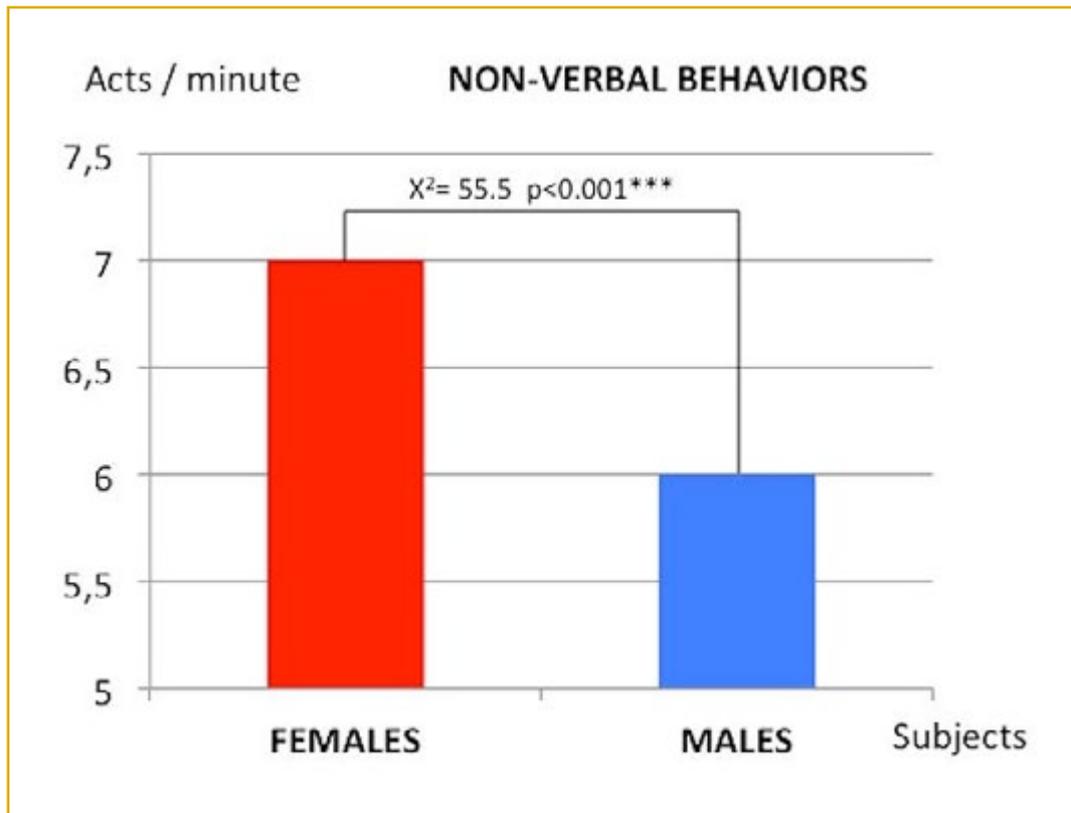


Figure 1. Behavioral flow (act/minute) per subject (females and males) on the total observation days in collective activity (BF) during 4-month confinement (SIRIUS-19 campaign). Statistic validation is on Chi-square test between females and males (df=1)

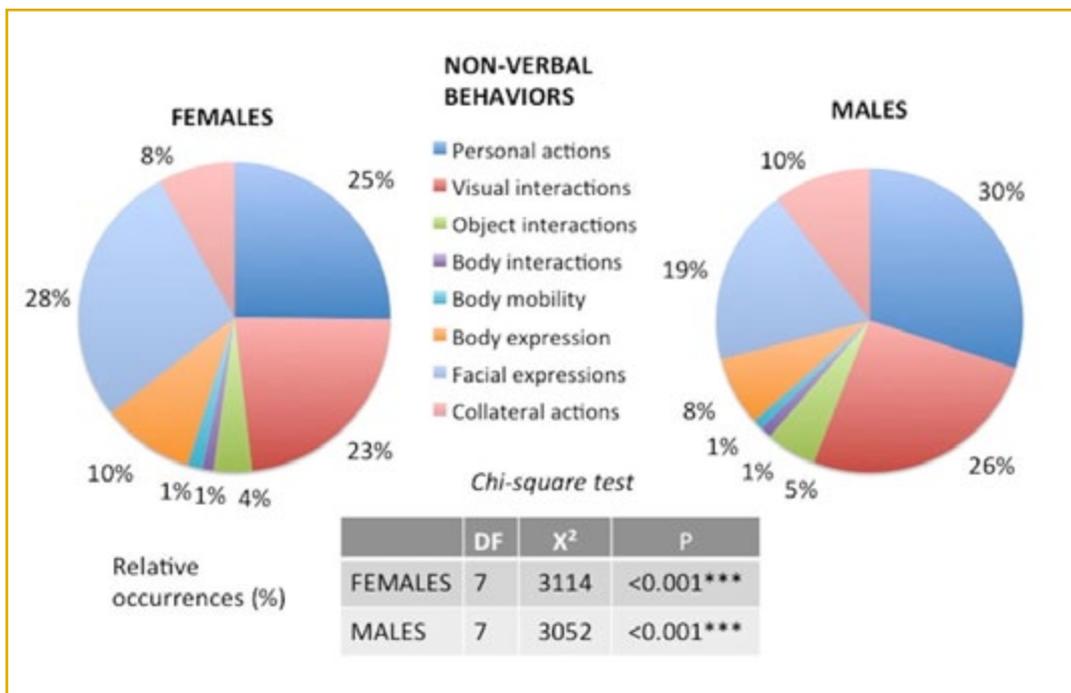


Figure 2. Percentage of non-verbal behaviors categories per subject (females and males) on the total observation in collective activity (BF) during 4-month confinement (SIRIUS-19 campaign). Statistic validations are on Chi-square tests between non-verbal behaviors (df=7).

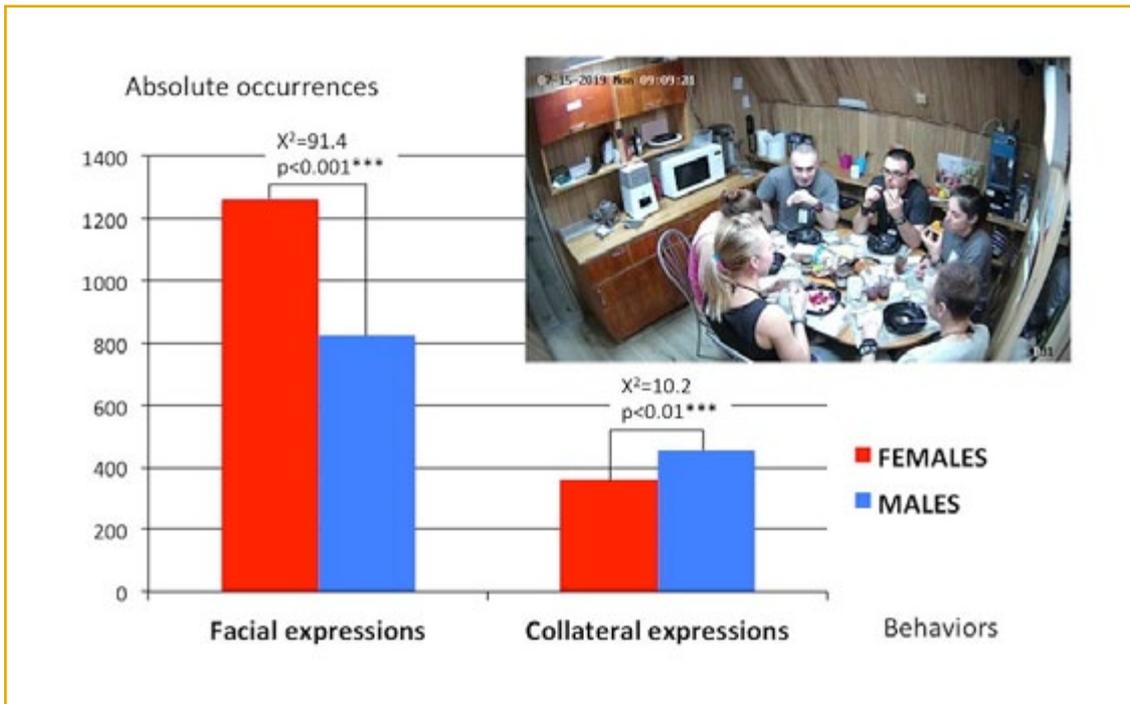


Figure 3. Occurrence of positive vs. negative non-verbal expressions according to the subjects (females and males) on the total observation days in collective activity (BF) during 4-month confinement (SIRIUS-19 campaign). Statistic validations are on Chi-square tests between females and males ( $df=1$ ).

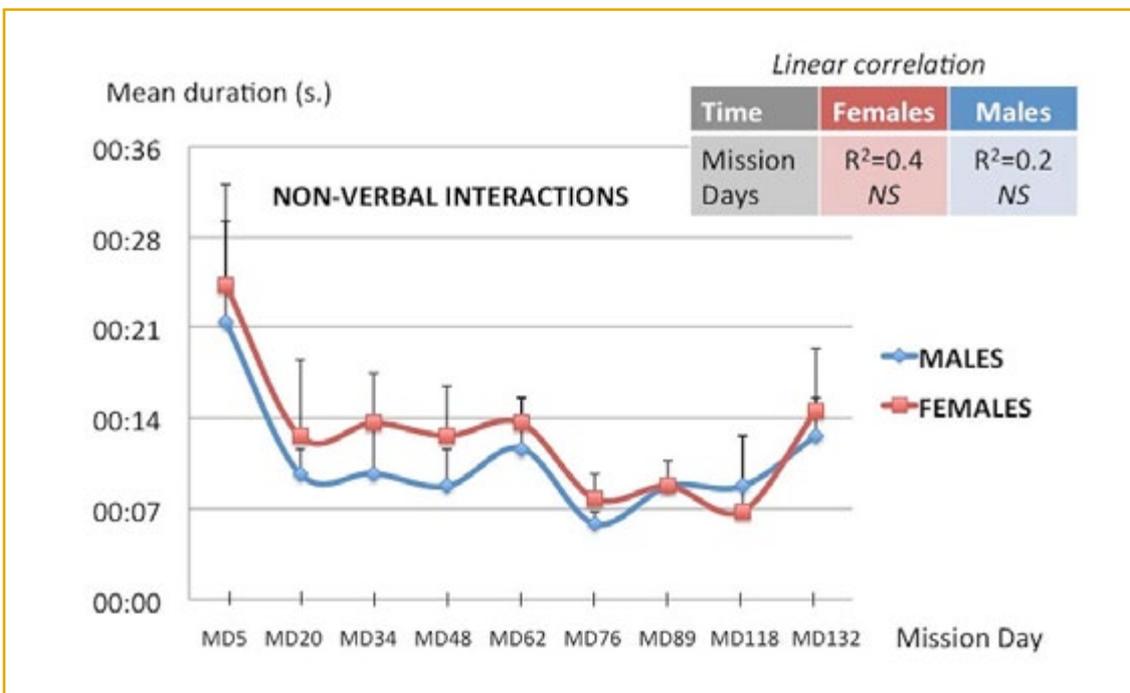


Figure 4. Mean duration (seconds) of non-verbal interactions according to subjects (females and males) in collective activity (BF) as a function of Mission Day (MD) during 4-month confinement (SIRIUS-19 campaign). Statistic validations are on standard deviation (sd) per day and on linear trends (correlation coefficient) over days.

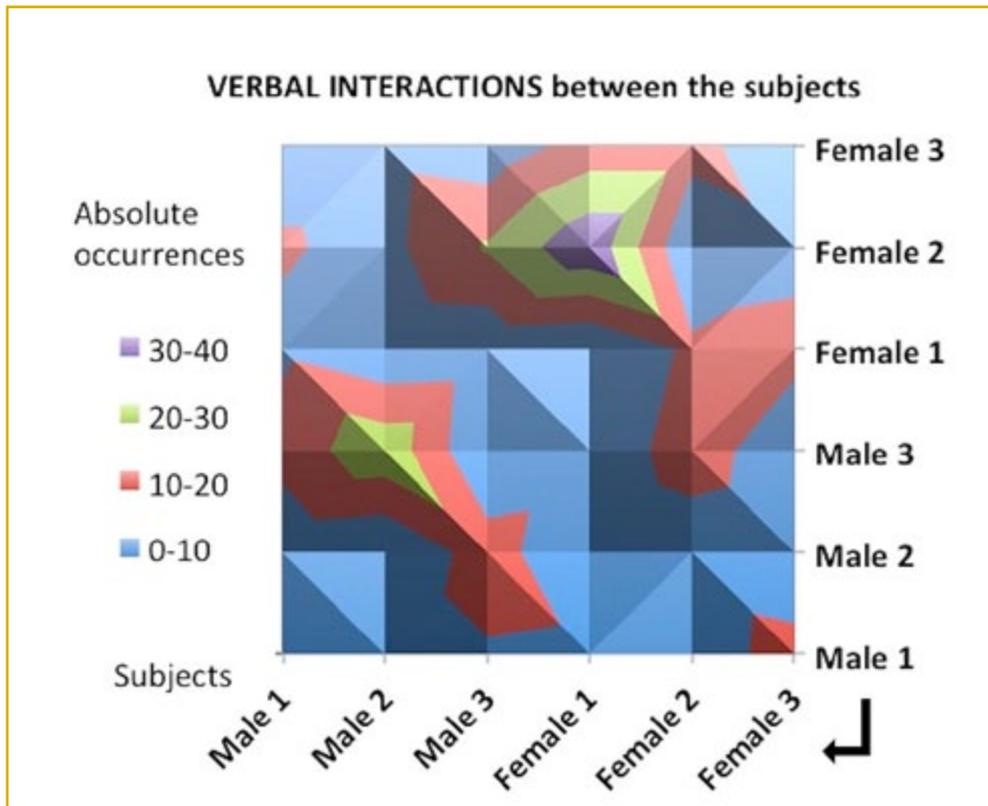


Figure 5. Occurrences mapping of verbal interactions between each subject in Group Discussion (GD) on the total observation days during 4-month confinement (SIRIUS-19 campaign). Three-dimensional representation of the superimposed values gives an overview of the related communications.

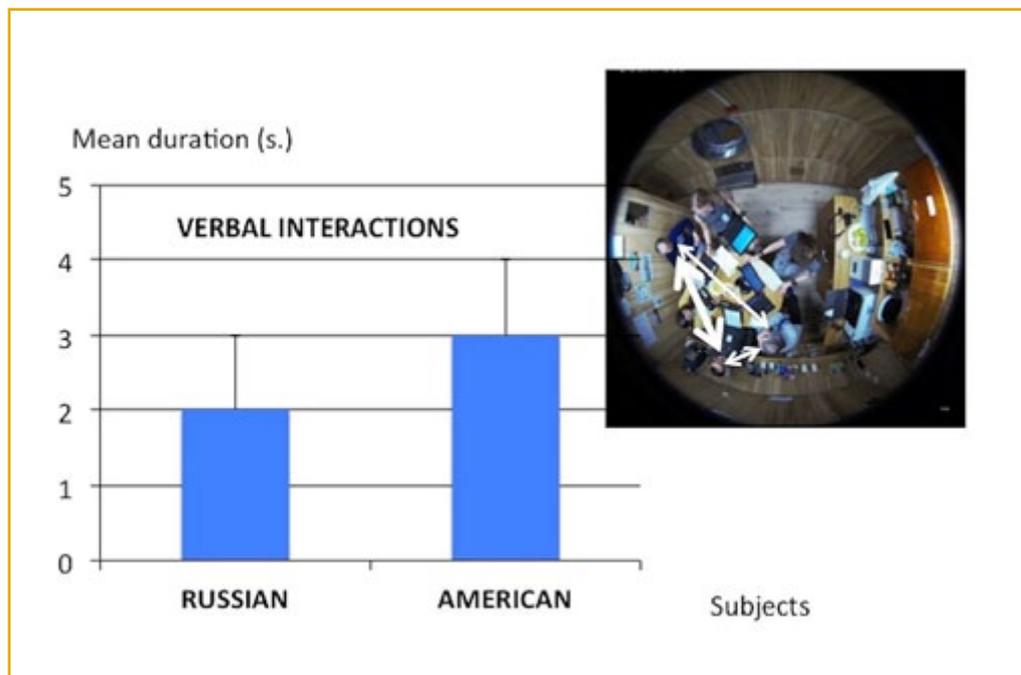


Figure 6. Mean duration (seconds) of verbal interactions between male subjects according to culture on the total observation days in Group Discussion during 4-month confinement (SIRIUS-19 campaign). Statistic validation in on standard deviation (sd) per Russian and American subjects.

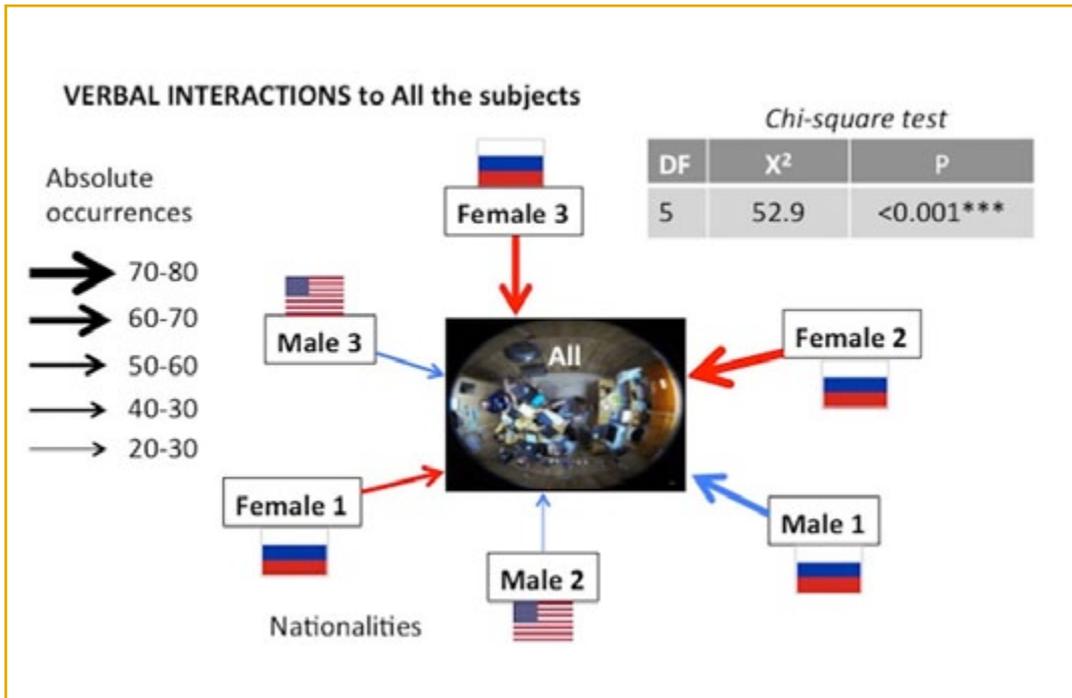


Figure 7. Occurrence of verbal interactions addressed to all subjects per gender and culture on the total observation days in Group Discussion during 4-month confinement (SIRIUS-19 campaign). Statistic validation is on chi-square test between subjects ( $df=5$ ).

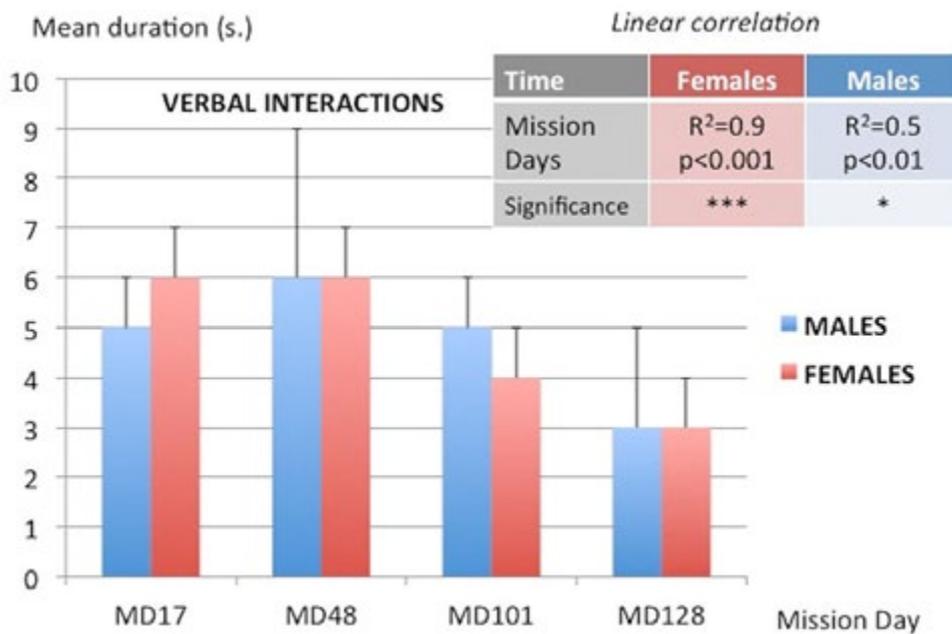


Figure 8. Mean duration (second) of verbal interactions according to gender in Group Discussion (GD) as a function of Mission Day (MD) during 4-month confinement (SIRIUS-19 campaign). Statistic validations are on standard deviation (sd) per day and on linear trends (correlation coefficient) over days.