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Cultural ethology as a new approach of interplanetary crew's behavior This paper (IAC-16-A.1.1.3) was presented at the 67th International Astronautical Congress, Guadalajara, Mexico, 26–30 September 2016.

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ABSTRACT

From an evolutionary perspective, during short-term and medium-term orbital flights, human beings developed new spatial and motor behaviors to compensate for the lack of terrestrial gravity. Past space ethological studies have shown adaptive strategies to the tri-dimensional environment, with the goal of optimizing relationships between the astronaut and unusual sensorial-motor conditions. During a long-term interplanetary journey, crewmembers will have to develop new individual and social behaviors to adapt, far from earth, to isolation and confinement and as a result to extreme conditions of living and working together. Recent space psychological studies pointed out that heterogeneity is a feature of interplanetary crews, based on personality, gender mixing, internationality and diversity of backgrounds. Intercultural issues could arise between space voyagers. As a new approach we propose to emphasize the behavioral strategies of human groups' adaptation to this new multicultural dimension of the environment.

Methodology: Potential outcomes of applying ethological methods to the study of culture-specific human behaviors are investigated. Ethological and anthropological tools are used, based on observations and descriptions of individuals acting in a micro-society with their rules for living, their work habits and their specific customs and values. We focus the present study on interpersonal communications and organizations in diverse space simulation experiments and analogous environments (Mars-500 experiment, Mars Desert Research Station - MDRS, Tara-Arctic expedition and Concordia South pole station).

Results: During the Mars-500 experiment, the crewmembers (RU, EU, CH) were differently involved in the activities of daily living. At MDRS in the Desert of Utah, the crewmembers (FR, US, AU, DK) communicated differently in verbal discussions. During the Tara drift in the pack ice, the crewmembers (FR, MC, EE, NZ, NO) were differently positioned in the collective space. At Concordia station, the crewmembers (IT, FR) were grouped preferentially according to their living habits. The results show that cultural heterogeneity has different effects on interpersonal communications and organizations. When considering the isolated and confined crews like an evolving micro-society in unexplored environments, our preliminary analysis raises new questions as to the phylogenetic and epigenetic bases to which cultural ethology linked to anthropology may help to answer.

Conclusion: Cultural values, in addition to social values and personal values, have to be taken into consideration for future space exploration.

1. Introduction

In the origin of species [1], natural selection has been described as one of the basic mechanisms of evolution. The naturalist's voyage aboard the Beagle was a trip around the world, covering a period of five years and surveying the coast of South America, to explore the continent and islands, including Galapagos. Observations of animals, plants and geology led to the theory of evolution and resulting controversies. Today, expeditions in these ecological environments [2] continue to provide information on the adaptation of the individuals to unexplored or little explored living space. Simply stated, biological evolution is based on genetic change in the phylogenesis, evolutionary development and

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diversification of species. As such, what would be the nature of the cultural evolution (based on behavioral changes in an epigenetic perspective) that considers environmental conditions as key factors in the mechanisms of human adaptation to unusual environments or extreme conditions?

During short-term and medium-term orbital flights, astronauts develop new spatial and motor behaviors to compensate for the lack of terrestrial gravity. Past space ethological studies have shown adaptive strategies to the tri-dimensional environment with the goal of optimizing relationships between the astronaut and unusual sensorial-motor conditions [3]. Results showed spontaneous, preliminary and integrative stages of adaptation, emphasizing new relationships between body references and those of the surroundings [4]. Over time, in building a spatial experience, the astronaut becomes free to move forward or backward, to orientate the head down or up, to manipulate floating objects, thus shifting from physical adaptation to cognitive adaptation in microgravity conditions. We would consider it as the bases of the evolution of humans in space. First appearing in Africa approximately 100,000 years ago, cognitive adaptation, with more complex social interactions [5], has been characterized by modern behaviors, with the capacity of understanding the natural world and strengthening the linkages between groups of different cultural niches.

In the future, challenges of space exploration include observations of human beings leading to new goals for investigations into inter-individual relationships of small groups, with an emphasis on the use of space, use of language and use of time. The process of long duration becomes a key factor if we consider, for instance, a manned mission to Mars. The Marsionauts will have, thus, been part of a social group in ethological terms and part of a micro-society in anthropological terms. In ethology, we developed studies in the wide panel of space simulators and analogue settings [6]. The salient findings were regarding changes of inter-individual distances over time according to the classification of Hall [7], who delineated intimate, personal, social and public spaces. We observed that in reduced habitats, the frequency of personal distance decreased, and the frequency of public distances increased, with a high level of social distance from the initial period to the final period of experimental campaigns [8]. Space sharing between individuals was also culture-dependent [9]. In anthropology, the “notion of space” holds a major position for the field studies and an obvious relation with the notion of culture [10]. The approach takes into account spatial relations as a central variable that influences human behavior and the underlying cognitive process. The concept of rituals is also important to investigate. During the 520-d experiment, simulating isolated and confined conditions on a mission to Mars (MARS-500), interaction rituals were expressed as solidarity experiences, shared emotions, and a shared focus of attention that led gradually to different levels of emotional energy [11]. We could interpret this as cooperative strategies. Cooperation is a behavioral response of survival in the ancient civilizations and far ethnicities [12]. Equivalent responses might occur in future micro-societies far from earth.

During a long-term interplanetary voyage, crewmembers will have to develop new social behaviors, based on cultural factors, to adapt to isolation and confinement and as a result of extreme conditions of living and working together. Clearly, psychosocial issues [13] need to be solved for extrapolating from non-evolutionary (exploration) to evolutionary (settlement) perspectives of humans on other planets [5]. Recent space psychological studies pointed out that heterogeneity is the feature of interplanetary crews, based on personality, gender mixing, internationality and diversity of backgrounds. It is of particular interest to consider individuals, each with unique personality traits and personal values [14,15], within an organizational structure such as an international crew. Besides cultural differences in patterns of moods shown in previous studies on board the International Space Station [16], the impact of diversity in the individual profiles with ethnical, professional and organizational backgrounds [17] on the social cohesion was demonstrated as efficient during space operations. Also, gender composition is an element of the heterogeneous organization of the group. It may help mitigating the interpersonal conflicts [12,18] but it may be negatively impacted by differences in culture and attitudes toward gender that create tensions between the group-members [19]. There is the quality of interactions [20,21] and a dimension of human relations that varies from conflictual and stressful to harmonious and effective [22]. Within such inter-relational networks, individual differences characterize the diversity.

Intercultural issues could arise between space voyagers [23]. A review of research pointed out that there are additional psychological issues, due to culturally heterogeneous crews [24]. Of course, differences in language skills or imbalance between the mother language and an unusual language, or a mismatch of various languages within the crew may have a negative impact on interpersonal communication. However, a common language that arises from a long-term process may differ from the usual one and become an efficient tool with its own rules and new conventions that a multi-language crew would form over an extended period of time. A personal accounting of the Mars-500 experiment found that mixed-culture was seen as an advantage, rather than a disadvantage, because the crewmembers attempted to understand each other and seek new knowledge accumulated by each of the cultures [25]. With contrasting skills, values and experiences, they learned to cooperate as equals [26]. Furthermore, interpersonal and communication competences along with international training, were complementary selection criteria for optimal crews for space exploration [27]. Considering cross-cultural shifts in a positive way, the isolated and confined crewmember benefits and evolves with his/her differences in culture.

As a new approach, we propose to emphasize adaptive strategies related to this new multicultural dimension in a wide panel of space simulation experiments and analogous environments (Fig. 1a–d): Mars-500 experiment, Mars Desert Research Station, Tara-Arctic expedition

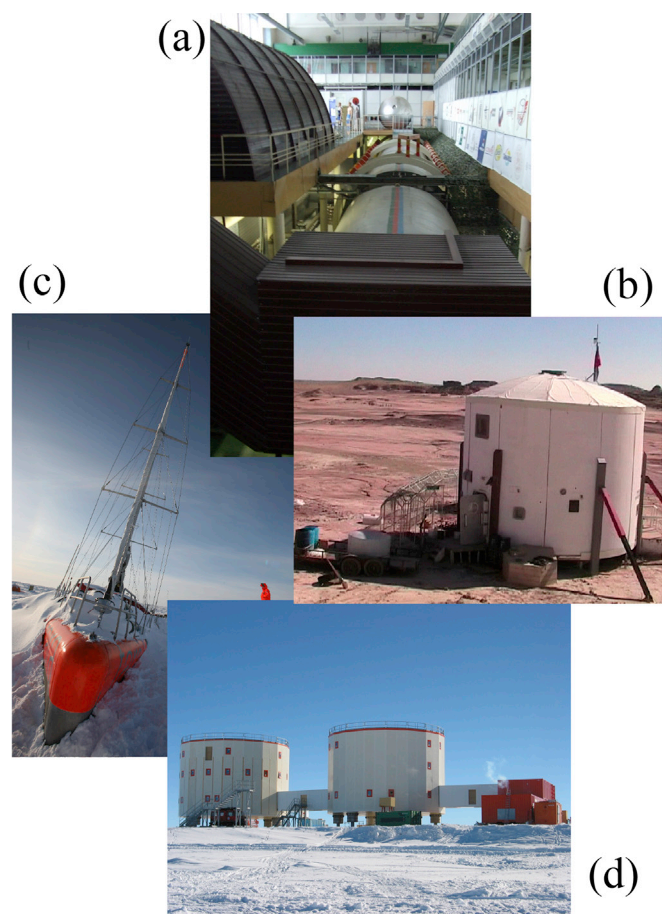

Fig. 1. Panel of space simulation experiments and analogous environments. (a) Mars-500 experiment; (b) Mars Desert Research Station; (c) Tara-Arctic expedition; (d) Concordia South pole station.