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Personal values and crew compatibility: Results from a 105 days simulated space mission

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\textbf{A B S T R A C T}

On a mission to Mars the crew will experience high autonomy and inter-dependence. “Groupthink”, known as a tendency to strive for consensus at the cost of considering alternative courses of action, represents a potential safety hazard. This paper addresses two aspects of “groupthink”: the extent to which confined crewmembers perceive increasing convergence in personal values, and whether they attribute less tension to individual differences over time. It further examines the impact of personal values for interpersonal compatibility. These questions were investigated in a 105-day confinement study in which a multinational crew (\(N=6\)) simulated a Mars mission. The Portrait of Crew Values Questionnaire was administered regularly to assess personal values, perceived value homogeneity, and tension attributed to value disparities. Interviews were conducted before and after the confinement. Multiple regression analysis revealed no significant changes in value homogeneity over time; rather the opposite tendency was indicated. More tension was attributed to differences in hedonism, benevolence and tradition in the last 35 days when the crew was allowed greater autonomy. Three subgroups, distinct in terms of personal values, were identified. No evidence for “groupthink” was found. The results suggest that personal values should be considered in composition of crews for long duration missions.

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1. Introduction

Future human space missions to Mars raise significant challenges with regard to maintenance of the health, performance and safety of crew members [1]. Such missions will not be comparable to any other undertaking humans have ever attempted because of the long distance of travel, the duration of permanent living under dependence of automated life-support systems, and the lack of short-term rescue possibilities in case of emergencies. Due to these factors and the restricted possibilities of psychological support from Earth during the stay in Martian orbit or on Martian surface, crew autonomy will inevitably be higher than ever before. The lack of a visual link to Earth is likely to add to the feelings of isolation and autonomy [2]. A major challenge for mission planning is to ensure the ability of the crew to function efficiently and safely under these conditions. Long duration space missions are a challenge for interpersonal relationships and feelings of coherence of crewmembers. Problems in this area can take on two forms. On the one hand, interpersonal tensions can become so large that the group disintegrates and the mission’s aim is jeopardized. On the
other hand, the coherence can become so strong that crewmembers lose their independence and critical evaluation skills.

An unequivocal recommendation from experts in space psychology is that emphasizing interpersonal compatibility in crew composition is important for a successful completion of any mission. On the basis of past theoretical and empirical research on psychological need fulfillment and value congruence in organizations in urban settings [3], it has been suggested that constellations of individuals should be avoided whose values, needs and belief are competitive or incongruent. Yet the empirical basis for this assumption in isolated and confined settings is weak as longitudinal studies that empirically relate similarities in individual values to crew cohesion and tension are missing. Studies on whether confined individuals over time develop more homogeneity in values and thus increasingly tend to share their views and perspectives also seem to be lacking. We addressed these issues during a 105-day confinement study in which a multinational crew simulated a number of scenarios related to launch, the outbound and return journey to Mars, and transfer to and from the Martian surface.

We adopted the theory developed by Schwartz and Bilsky [4] which defines values as desirable, trans-situational motivational goals of varying importance, and which serves as guidelines for action. The model derives ten types of values: self direction, stimulation, hedonism, achievement, power, security, conformity, tradition, benevolence, and universalism (see Table 1). To some degree individual value systems have been found to be affected by experiences from spaceflights [5] and polar expeditions [6]. Nonetheless, the relative stability of values across context and time demonstrated in large samples makes them useful psychological constructs. Being closely linked to motivation, values guide attention and action to intrinsically rewarding social, intellectual, and emotional opportunities [7]. As values serve as standards for judging the behavior of self and others, they are likely to play an important role in tension between crewmembers and for subgroup formation during human space missions. This idea is supported by a large body of evidence within the field of social psychology showing that attitudinal similarity is a powerful determinant of interpersonal attraction.

### 1.1. Value congruence and group dynamics

Extensive studies of humans in a variety of organizational settings and national cultures indicate that values differentially relate to preferences in areas including leadership, appropriate gender relationships, structuring of tasks, sources for work motivation, and self reliance [8]. Anecdotal [9] and empirical [10,11] evidences underscore that differences in these areas have been a source of disagreements that have strained the ability of international space crews to mount an optimal, unified performance. Sarris [12] found that subjective fit with station culture predicted satisfaction with station membership among Antarctic expeditioners. Results from one space station simulation study suggested that cultural differences in values played a role in many misunderstandings and conflicts that took place within and between two confined crews; both national and organizational factors were implicated. This resulted in a breakdown of cohesion, and group rancor that occurred during the mission affected not only the isolated crews but also the participating agencies [13,14]. One inherent limiting factor of studies involving small sample sizes is that we cannot isolate the effects of culture from individual idiosyncrasies. Mindful of this consideration, we solely focus on values at the individual level in this study.

While interpersonal tension is an expected correlate of prolonged confinement, cohesion sometimes increases over time as people adjust to one another. In a study of seven men and women participating in a 3-week Arctic scientific expedition, Palinkas and his colleagues [15] reported significantly higher tension levels prior to the start of the mission than during the mission itself, where the crewmembers seemed to adapt to their situation. Similarly, in a 135-day Mir space station simulation study, Kanas and his colleagues [16] found significantly less tension during the last half of the isolation than during the first half although other researchers [17] failed to demonstrate this effect. Sharing a unique experience and mutual excitement over the mission are factors that seem to enhance crew member communication in space [18]. Interestingly, researchers have noted that in the process of cohesive group formation, crewmembers begin to regard each other as very “similar” or “close” in terms of sharing common values and belief [19]. Simultaneously, those crewmembers who do not perceive themselves as close and who do not attempt to understand or share common group values run the risk of becoming a “stranger” or an “alien”, and to become socially excluded from group activities [17,20,21].

Social pressure is essential to establish a set of agreed rules capable of influencing the team members’ behavior and facilitating crew adaptation and coordination. However,

### Table 1
Definitions of personal values.

<table>
<thead>
<tr>
<th>Value type</th>
<th>Defining motivational goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-direction</td>
<td>Independent thought and action-choosing, creating, exploring</td>
</tr>
<tr>
<td>Stimulation</td>
<td>Excitement, novelty, and challenge in life</td>
</tr>
<tr>
<td>Hedonism</td>
<td>Pleasure or sensuous gratification for oneself</td>
</tr>
<tr>
<td>Achievement</td>
<td>Personal success through demonstrating competence according to social standards.</td>
</tr>
<tr>
<td>Power</td>
<td>Social status and prestige, control or dominance over people and resources</td>
</tr>
<tr>
<td>Security</td>
<td>Safety, harmony, and stability of society, of relationships, and of self</td>
</tr>
<tr>
<td>Conformity</td>
<td>Restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms</td>
</tr>
<tr>
<td>Tradition</td>
<td>Respect, commitment, and acceptance of the customs and ideas that one’s culture or religion provides</td>
</tr>
<tr>
<td>Benevolence</td>
<td>Preserving and enhancing the welfare of those with whom one is in frequent personal contact (the ‘in-group’).</td>
</tr>
<tr>
<td>Universalism</td>
<td>Understanding, appreciation, tolerance, and protection for the welfare of all people and for nature</td>
</tr>
</tbody>
</table>
too much cohesion can also be a threat to the mission. A concern is that highly cohesive crews during long duration missions are vulnerable to a phenomenon known as “groupthink” [21,22] which is characterized by symptoms involving illusions of invulnerability, reluctance to express concerns or disagreement about decisions, pressure towards conformity, and stereotyped views of people outside the group [23]. “Groupthink” has been associated with low quality performance since members are too concerned with getting along and are reluctant to express disagreement, and could therefore endanger the mission in situations of crises. A comparatively large body of research is available showing that workgroup performance might profit from a heterogeneous team composition [24]. The creative tensions associated with diversity may encourage mutual inspiration and ensure richness of input that in turn may facilitate problem solving when dealing with complex tasks. This capacity is likely to gain increasing importance as crews become more autonomous such as during a future mission to Mars.

1.2. The present study

The aim of this paper is to develop a better understanding of how diversity in values relates to crew cohesion and psychological compatibility during long duration missions. We were also interested in examining the extent to which crew members either adopt more similar personal values over time leaving them more vulnerable to “groupthink” or that the group disintegrates and tension between cliques evolves. Perceived homogeneity in values does not necessarily correspond to actual similarities. Whereas the former aspect seems most relevant to crew cohesion, the latter aspect may be more important for the crew’s problem solving capacity. This study will consider both aspects. Finally, we were interested in the question to what extent crew members view interpersonal tension as being associated with value heterogeneity.

Based on the literature review three hypotheses were tested:

1. Members of subgroups within the crew show similarities in personal values.
2. Crew members show increasing convergence of values over time.
3. Individual differences in values become less salient as sources of intra-crew tension over time.

2. Material and methods

2.1. Subjects

The study was conducted from March 31 to July 14, 2009 and involved a crew of six men: two Russian cosmonauts (one was the Commander), a Russian medical doctor, a Russian sports physiologist, a German mechanical engineer, and a French airline pilot. Their age ranged from 25 to 41 years. Three of the Russian crew members worked at the Institute of Biomedical Problems (IBMP) in Moscow, where the simulation study took place. Three of the Russian crew members had limited English skills and the two West European subjects had limited Russian skills. Four crew members were either married or in a long term relationship.

2.2. Procedure

The environmental parameters (humidity, pressure, gas composition, and temperature) in the chambers corresponded to International Space Station standards. The total volume of the chambers was 500 cubic meters. Crew members had separate sleeping compartments. The crew had to follow a daily schedule that specified work, physical training, recreation and the different experiments (including questionnaires) to be completed each day. They followed a set rotation with a 24 h night shift each 6th day. Sunday was a day off except for the crew member on duty. They were allowed to sleep on the following day until lunch time. The daily diet was fixed, and the crew was not to deviate from this. However, two crew members did not consume all the planned food items, and consequently their weight decreased significantly. Therefore, these crew members received alternative food after day 45. The French and the German crew member received news at a daily basis by video-clips from television news, whereas the Russian crew members received news in a written format three times each week. The mission was separated into three 35 days cycles, and after each cycle the research protocol was repeated. A high autonomy phase was implemented in the last 35 days. During the first two-thirds of the mission, the crew interacted in real time and as frequently as they wanted with outside monitoring staff (“mission control”), but during the last third (from day 70) they had more responsibility for monitoring and planning their own activities and experienced a 20 min communication delay with the outside (one direction), such as they might expect on the surface of Mars (a “high autonomy” condition). From day 70 no supply from the outside was provided to the crew in the chambers. Communication with the mission control was in Russian.

Before the confinement, the investigators met with the crew members and provided them with information and training for the experiment. All materials were provided in Russian and English. The Portraits of Crew Values Questionnaire (PCVQ) was answered once every month throughout the confinement period. The questionnaire was answered once 14–16 days before the start of the confinement, and once 8 days following the termination. Data were stored at a local server.

2.3. Instruments

2.3.1. The portrait of crew values questionnaire (PCVQ)

The PCVQ consists of three parts: Part 1. Portrait Values Questionnaire (PVQ) [25] was used to measure personal values. A short version of the PVQ was used that includes short verbal portraits of 21 different people, gender-matched with the respondent. Each portrait describes a person’s goals, aspirations, or wishes that point implicitly
to the importance of a value. For example: “Thinking up new ideas and being creative is important to him. He likes to do things in his own original way” describes a person for whom self direction values are important. “It is important to him to be rich. He wants to have a lot of money and expensive things” describes a person who cherishes power values. For each portrait, respondents answer: “How much like you is this person?” on a six-point response scale from “very much like me (6)” to “not like me at all (1).” Respondents’ values are inferred from their self-reported similarity to people described implicitly in terms of particular values. Studies in numerous countries demonstrate the reliability and validity of the values measured with the PVQ [26]. Table 1 provides definitions of each value construct in terms of its central goal.

Parts 2 and 3 of the PCVQ were designed for this study. Each part consists of a description of the values as defined in Table 1, with the exception of universalism, which was considered to be less relevant for group dynamics of confined crews. For each value, the crew member was asked to indicate how much he felt that the members of the crew differed from each other (part 2), and how much he felt that differences between crew members contributed to interpersonal tension within the crew (part 3). Answers were given on five point scales (not at all, a little, some, quite a bit, and very much).

2.3.2. Post-mission interview

Semi-structured interviews, each lasting for approximately 1.5 h, were conducted 2 or 3 days following the termination of the confinement. The interview guide was constructed based on previous simulations [13], and focused on: (a) sources of stress and individual coping behaviors; (b) critical incidents impacting on the levels of tension within the crew, or between the crew and the Mission Control; and (c) links between mission phases (including time) and adaptation at individual and crew levels. Two researchers were present during the interviews. A translator was used during interviews with three Russian crew members who were not fluent in English. Interviews were recorded and transcribed. The Nvivo 8 [27] software package was used for organizing and analyzing the qualitative data from the interviews. The transcription was done by two research assistants blind to the research hypothesis. The analytic approach was based on template analysis [28] that involved a classification of responses into predefined categories or themes central to the research questions. New categories were created to capture information that did not fit any of the established categories. Finally, consistencies and discrepancies in the reports of crew members were registered.

3. Results

The analysis of the data used a combination of quantitative and qualitative methods. This mixed-methods approach enabled us to combine the rigor of statistical methods with the richness in detail of qualitative methods. The picture of the data, as revealed in the quantitative analyses, was validated in the qualitative approach. The qualitative methods had another advantage in that they complemented the inherent problems of the statistical methods due to the small sample size (of 6 crewmembers). The data analysis was more aimed at the identification of patterns, to be confirmed in the qualitative analyses, than at the identification of significant effects.

3.1. Quantitative analyses

The first hypothesis of the study dealt with one symptom of “groupthink”, namely the tendency of crew members to regard each other as becoming more similar over time in terms of sharing the same values. More specifically, in operational terms the hypothesis predicts a decrease in mean scores and a reduction in standard deviation on the value diversity scales (PCVQ part 2). The second hypothesis dealt with another aspect of “groupthink”, a concern about maintaining harmony within the crew at all costs. This would imply that individual differences in values are becoming less salient as perceived sources of tension among the crew members over the course of the confinement (PCVQ part 3).

We tested these hypotheses using multiple regression procedures. The independent variables were 6 measurement times (coded as 1–6). Dependent variables were scores on perceived differences (homogeneity) (PCVQ part 2) and tension attributed to value differences (PCVQ part 3). We also used standard deviations as dependent variables; more specifically, we computed standard deviations of the perceived homogeneity and tension per time point. For each of these five dependent variables (i.e., means of perceived differences and tension, standard deviations of both variables, and personal values) we computed standardized regression coefficients (which are the same as correlation coefficients as there is only one predictor). For example, we computed 9 standardized regression coefficients for the means of perceived differences (again, with time as the independent variable). These 9 regression coefficients (one for each of the values) were then compared to the theoretically expected distribution of the regression coefficients if there would be no correlation between time and the dependent variable.

We visually compared the expected frequency distribution with the empirically obtained distribution and checked for systematic differences. The results are shown in Fig. 1. The distribution of the perceived differences (PCVQ part 2) shows a bias toward positive values, which means that individual differences in values were seen by crew members as increasing and homogeneity as decreasing over the course of the confinement. The standard deviations do not show the expected decrease over time either. Taken together, these results do not support the first hypothesis; if anything, the data suggest the opposite pattern in which individual differences are seen as increasing over time.

The picture for tension attributed to value diversity (PCVQ part 3) also suggests salient differences between expected and obtained regression coefficients. More specifically, there are three strong, positive (and indeed significant) regression coefficients, indicating that tension attributed to three values (benevolence, hedonism, and tradition) increased over time (we come back to these changes in the qualitative part of the results). Finally, the standard deviations of the perceived tension scores did
not show any decrease either. Thus, our second hypothesis was not confirmed.

We also analyzed individual values before and during the mission based on data from PVQ. We found slightly more strong increments and decrements in values than would be expected if values were unrelated to time. The changes we found were meaningfully related to events during the mission. For example, hedonism of crewmembers having problems with the food went up over time (see Section 3.2) whereas the benevolence of some crewmembers decreased over time. Table 2 presents the average scores of personal values across time and the correlation between the value and time point.

3.2. Qualitative analysis (post-mission interview)

3.2.1. Subgroups

Subjects were asked about whom they felt closest to within the crew. Across the five interviews, there was strong agreement that crew members could be divided into three distinct subgroups that we refer to as A, B, and C. These subgroups cut across nationalities. An inspection of individual value scores on PVQ revealed similarities between members of the same subgroups. The two members of subgroup A shared a stronger emphasis on hedonism. One member of subgroup A obtained the highest scores on power among all six subjects suggesting that he possessed the strongest motivation for dominance. The two members of subgroup B shared a strong emphasis on tradition, conformity, and benevolence. Subgroup C was less distinct in terms of values although there was tendency that both subjects scored low on conformity and tradition relative to the four other crew members.

3.2.2. Intra-crew tension

On the whole, low levels of intra-crew tension were described. Several crew members expressed that they had...
been conscious about avoiding confrontations. Nonetheless, sources of interpersonal tension described by the majority of the subjects involved differences in acceptance of the diet, obedience to instructions, and relationships with the outside. We shall review some of the comments made by crew members in each of these areas.

3.2.3. Dissatisfaction with the diet

Dissatisfaction with the diet was presented as a major stressor for crew members, in particular members of subgroup A. One commented: “For me it was a big stressor. And all the time, especially the first month, I was hungry all the time. And angry.” This situation was described as having a negative impact on interactions between members in the crew as a whole. “For me it was just difficult to work with some of the others because I thought they were moody. (...) I really felt that food had a strong impact.” Some negative impacts were also described after members of subgroup A was offered a different diet, around day 45 of the confinement. One of them noted that: “It was bad food. ‘And when we lost more than 10 kg, our chiefs changed our meal plans and added some food for us. It was trouble because other crew members looked at us with hungry eyes and we tried to eat separately from our crew members”. However, another subject commented that: “In the last part of the study they had more food and it was much better for all of us I think”.

3.2.4. Obedience to instructions

Several incidents of tension were described that involved differences between crew members in compliance to written instructions. One of them noted that this could be due to their cultural backgrounds. It was in some situations when Earth, gave us some instructions, and Russians made their own way to how it was correct. But Europeans followed the instructions of the Earth like blind”. Differences in professional experience were emphasized by one crew member: “For cosmonauts it’s easy, because we are used to work with on board documentation. It is a rule on board that if you are working according documentation it’s not your fault if something is going wrong”.

Being meticulous, organized, and committed to procedures appeared to be distinct characteristics of members of subgroup B. One of them commented that: “He thinks very slowly because he is very organized. And like this he cannot always be in time. So I was nearby and tried to help him. I think that we were in a symbiotic relation”. Several incidents of tension between this subgroup and other crew members were described. One of the subjects in subgroup B described his frustration with what he described as a lack of responsibility on the part of the Commander for work coordination (for example, cleaning), and for giving priority to personal entertainment in front of work.

3.2.5. Relationships with the outside

The relationship between crew members and Mission Control personnel was generally described as good with no major conflicts. Nonetheless, several situations were described in which the Mission Control personnel were viewed as not being sufficiently sensitive to the specific demands and needs of a crew, or not providing justifications for their decisions. One crew member commented:

In the crew we had... one doctor, one doctor in physiology, one captain in the German army, one airline captain. We are a population that are responsible and can do a lot of things as long as we know why. We do not just do things.

Two crew members expressed frustration about the response of the Mission Control when the crew asked for permission to change the diet for subjects who were loosing weight. The introduction of increased autonomy and less frequent contact with the Mission Control was described by the majority of crew members as a positive shift. Sleep deprivation experienced by some crew members became less of an issue in the autonomous phase because those crew members, who coped by sleeping in the afternoon (3–5 pm) were woken up less frequently by the phone.

4. Discussion

Researchers have voiced concerns that the high autonomy and isolation that crews will experience during a mission to Mars may lead to the development of “groupthink” which can seriously impair crew performance and interactions with the ground. This paper has addressed two aspects of “groupthink”. Firstly, we examined the extent to which crew members adopt more homogeneity in values over time. Secondly, we investigated whether individual differences in values become less salient as perceived sources of tension. Our analysis revealed no such effects. On the contrary, crew members tended to regard each other as more different in personal values with time. Also, interpersonal tension attributed to value differences increased significantly over time. This was in particular the case with regard to hedonism, tradition, and benevolence. Interestingly, similarities and differences in the two former values also seemed to play a role in the formation of the subgroups within the crew.

4.1. Convergence in values and intra-crew tension

Interpersonal tension attributed to value differences showed a marked increase around the time when the crew was allowed higher autonomy. During these last 5 weeks of the confinement they had more responsibility for monitoring and planning their own activities and also experienced a 40-min two-way communication delay with the outside. It is important to note that our results do not necessarily mean that intra-crew relationship in general became less harmonious over time. Rather the results may suggest that individual differences became more salient when strains from outside factors were reduced. However, we shall also discuss other possible contributing factors.

Several crew members reported having sleeping problems in the initial period of the confinement. These difficulties decreased as crew members adapted to the living and working conditions, such as continuous noise.
and the work rest-cycle. Dislike of the food, and subsequent reduction in food intake of two crew members was presented as a major stressor in the first third of the confinement by all crew members. This situation was reported to have a strong negative impact not only on the mood and well being of the two crew members but it also created tension within the crew as a whole and between the crew and the Mission Control. As an attempt to resolve this situation, a different diet was offered only to these crew members. Interestingly, we observed a significant rise in tension attributed to individual differences in hedonism and benevolence in our data collected in the measures following this event. One possible explanation indicated by crew members in the post-mission interview, is that differential treatment of crew members caused irritations and resentment.

Data from the post-confinement interviews suggested that the crewmembers' perceptions of stress decreased when the crew was allowed greater autonomy. Several subjects indicated rising tension and frustrations in relation to Mission Control before the high autonomous conditions were implemented, and described the reduction in the contact with the outside as “a relief”. Most crewmembers described the atmosphere within the chambers as being “calmer” during the high autonomy condition, which allowed them to focus more on their work. Likewise, observations by other investigators suggest that increased autonomy was well-received by the crew and that mission goals were accomplished [29]. This is in line with previous research showing that during long-term conditions of isolation and confinement, crewmembers want to separate from the influences of outside monitoring personnel [30]. Although evidence from space is largely anecdotal, strict adherence to timelines has been reported to have a strong negative impact not only on the mood and well being of the two crew members but it also showed the strong effects of language differences have been found to affect G.M. Sandal et al. / Acta Astronautica 69 (2011) 141–149

**4.2. Values and interpersonal compatibility**

Individual differences in tradition, hedonism, and benevolence not only appeared to cause more interpersonal tension over time, but the two former values also seemed to play important roles in the formation of subgroups. Information from the post-mission interviews showed three distinct subgroups. Members comprising one subgroup (A) shared a strong motivation for hedonism (pleasure and sensuous gratification). The refusal of these crew members to eat certain food products, and their subsequent weight loss, is consistent with behavioral expressions associated with hedonism. Their forceful reaction to their dislike of the food, that ultimately necessitated a change in the predetermined diet, may to some extent reflect the strong power motive of one of these crew members (indicated by scores on the PVQ). A second subgroup (B) shared conformity values that may have been expressed through a strong emphasis on structure and commitment to task accomplishment according to specified standards. Several incidents of tension between members of this subgroup and other crew members were reported, and may be reflected in the rise in interpersonal tension from individual differences in tradition/conformity observed in the last third of the confinement. For example, one of them accused the Commander for not taking sufficient responsibility for the hygienic standard within the chambers and the coordination of tasks between crew members. The third subgroup (C) was less distinct in terms of value congruence on the PVQ, but they were noticeable lower on conformity and tradition than subgroup B. Their psychological compatibility may primarily be related to similarities in personality attributes.

While a concern has been that clique formation in multinational crews will occur along national/cultural/language lines, it is noticeable that members of two subgroups (B and C) were of different nationalities. One of them consisted of members with limited abilities to communicate in a common language. Within the crew as a whole, only one of the Russians spoke fluent English and the Russian language skills of the German and French members were limited. Although fluency in a common language has been claimed to represent a basic requirement for interpersonal compatibility [2], such differences were not presented as a challenge for crew interaction in this study. Astronauts and cosmonauts have endorsed the need for a common language during space missions, and language differences have been found to affect throughout the course of confinement. At the end of these confinement studies, most of the bilateral communications between crewmembers had broken down, almost all communication went through the commander of the crew, and one of the subjects was totally isolated. Even though other results reported in the literature do not always show the same strong effects, at least episodes of latent or open hostility between crew members, and tendencies to form cliques have usually been observed after some time in analog environments and during spaceflight [21,31,32].
crewmember compatibility in space analog environments on Earth [18]. For example, language differences were implicated in some of the group disintegration that was observed during the SFINCSS space simulation study. The sensitivity to language problems may be stronger when intra-crew tension is high. That such effects were not observed in this study might be due to that personal sympathies were sufficiently strong to cross cultural and linguistic barriers.

5. Conclusions

Caution is required in generalizing these results due to the small sample size and the limitations connected with ground based simulations. Clearly, simulation studies cannot completely reproduce the living conditions experienced by astronauts and cosmonauts in space. For example the experiment took place in full gravity with no worries about radiation exposure from deep space. One must also question whether the dynamics among people who are cognizant that they are psychological subjects in a study and who have the ability to leave the chambers on short notice are comparable to the psychological reactions of crews during long duration space missions. Despite these possible limitations, however, simulations have allowed the identification of behavioral issues observed during actual spaceflights and among personnel operating in other isolated and confined settings. A further strength of this study was that the crew consisted of two trained cosmonauts and two others had been candidates for the recent astronaut selection campaign in Europe. Thus, they may be relatively representative for the population from which space crews are drawn.

Our study makes several contributions to the space psychology literature. Specifically, we suggest that values become more important for interpersonal compatibility with increasing mission duration and autonomy. Future space simulation studies should disentangle the relative impact of these factors, for example by introducing high autonomy conditions earlier in the confinement. Our findings suggest that convergence in values should be considered in crew composition in order to enhance team performance and smooth interpersonal interactions during long-term space missions. Nonetheless, removal of all potential sources of interpersonal tension may not be an optimal goal due to the risk for “groupthink”. Although we did not find evidence of “groupthink” in this confinement study lasting for 105 days, we cannot exclude the possibility that this phenomenon will occur on a future mission to Mars that is likely to last for a much longer time.

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