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Crew Interaction in Extended Space Missions

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Abstract: Detection of the extent of common values in a cohesive space crew has become an important trend in modern space psychology. It is known from the works of Ch. Osgood that the semantic differential scale is a reliable way to obtain objective information on the emotional attitudes towards a topic of interest. Within the frame of the Russian space experiment "Interactions" on the International Space Station (ISS), a computerized survey, the Personal Self-Perception and Attitudes (PSPA), was developed for analyzing the subjects' emotional attitudes toward their social environment. In the course of the PSPA procedure, the crewmembers rate each other and themselves (in the past, present, and future) using the criteria previously personally chosen. These criteria should be regarded as their personal values. A total of 30 subjects have already completed the study on board the ISS. The main tasks of the study are: (1) to define individual and group values and the extent of group identification reflected in sharing these values; (2) to determine the impact of cross-cultural factors on mutual perceptions and self-perceptions in space crews and with the Mission Control Center (MCC); (3) to study changes in the space crews' group cohesiveness and structure as they are exposed to the stress of the extended space mission environment. The data obtained indicate an increase in a "psychological distance" between the crew and the MCC personnel versus increased crew cohesion. The results gained made it possible to identify the most significant categories of values common to the subjects from the professional cosmonaut group. The priority of these shared values for each subject is an important condition for the formation of a cohesive crew.

Keywords: interactions; values; attitudes; cohesion

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1. Introduction

At the present time, the national space agencies of Russia, the United States of America, and China have indicated a goal to implement the flight and landing of the crew on the surface of the Moon. The difficulty and unique character of the tasks that the astronauts will solve on the Moon will be higher than during the flights in low near-Earth orbits, and the success will depend on their ability to effectively interact as a team [1–3]. In comparison with the teams on Earth, the necessity to maintain normal relationships and intra-group cohesion becomes much higher in autonomous space flight due to the lack of external support and the requirement to rely on internal resources. At the same time, it can be assumed that the stronger gender, racial, national, and cultural differences exist between people or teams, the greater will be the difficulties in establishing harmonious and productive relationships [4–6].

2. Theoretical Background

The effectiveness of cooperative activity in professional groups is determined by group cohesion. Therefore, recent studies in the field of psychology of small groups working in extreme conditions are focused on the study of factors that are significant for the functioning of a group and determine the degree of its cohesion [7–10].

Our study is based on the understanding of cohesion as a derivative of the quantity and strength of group members' mutual positive attitudes [11]. The characteristics of human behavior in small groups are determined by self-perception, the perception of other members of the group, identification with the group, and its values and goals. According to Turner [12], for a cohesive group, a high degree of mutual identification of its members can be expected. The similarity in values and attitudes contributes to the development of interpersonal attraction between the group members. At the same time, the resulting cohesion leads to an increase in the group's influence on its members regarding similarities in these characteristics. It can be assumed that in a cohesive group, the values system of its members is united and shared by the majority of its members.

The study of the content and similarities between the values of cosmonauts or astronauts is especially significant due to the need to determine the optimal composition of space crews mixed in terms of gender and nationality. One of the first and most outstanding examples is P. Suedfeld's study [13], devoted to the quantitative content analysis of the astronauts' memories, using Schwartz's values classification as categories [14]. The results of the study showed an obvious increase in the importance of universalism and spirituality values in astronauts after performing a space flight.

The role of personal values in the formation of a cohesive group in the conditions of simulated space flight in chambers was studied by G. Sandal [9], who also used Schwartz's values model. The gained results demonstrated the role of individual differences in values as a source of interpersonal tension in an isolated small group, especially with the increase of the mission duration and crew autonomy. I. Solcova, in her studies, proved that cohesion under isolation is accompanied by a more favorable assessment of interpersonal interaction, as well as an increase in conformity [15].

In a cohesive group, people to whom a person feels sympathy are often perceived as similar and psychologically close to themselves; therefore, in such a group, a high degree of mutual identification of its members can be expected. Thus, cohesion is determined by the perception of oneself and other crewmates as similar or psychologically close. By "psychological distance", we mean the perceived dissimilarity (difference) between other people and our own image of the "Self". Our hypothesis is that an increase in the "psychological distance" between the space crewmembers may indicate negative cohesion dynamics. Conversely, an increase in cohesion will be accompanied by an increase in perceived similarity, i.e., identification with other members of the group.

3. Methodology

3.1. Sample and Procedure

The Russian space experiment "Interaction-2", which started in 2015 during the 43rd ISS expedition, was a continuation of the space experiment "Interaction-Attitudes" (2009–2014) [16,17]. In addition to the statistical verification of the previously obtained results, the "Interaction-2" project designated as its main goal the assessment of national differences impacting the crewmembers' values priorities and cohesion and identification with the group, as well as the perception of such key aspects of interaction as leadership, conflict resolution, and the volume and quality of communication with the Mission Control Center (MCC).

At the moment, 30 participants have completed the "Interaction-2" program, including 1 representative from the United States and 1 representative from Kazakhstan. Two Russian crewmembers did not participate as subjects in the "Interaction-2" space experiment. All subjects were men of average age (full years)—(46.5 ± 5.9).

The experimental protocol was approved by the Human Research Multilateral Review Board (HRMRB, protocol number 14-008, 17 February 2015). All subjects signed an informed consent to participate in the "Interaction-2" studies.

The studies were carried out according to the following schedule:

- Pre-flight training and baseline data collection—30–60 days before launch;
- In-flight data collection—once in 2 weeks, starting from the 3rd week of the flight;

- Post-flight study—on the 10th day after landing.

Due to the termination of shuttle flights in July 2011 and the need to use exclusively Russian Soyuz spacecraft, which could lodge only 3 people, the following approximate scheme for launching crews was developed, allowing 6 people (representatives of various space agencies) to be on board at the same time (Figure 1):

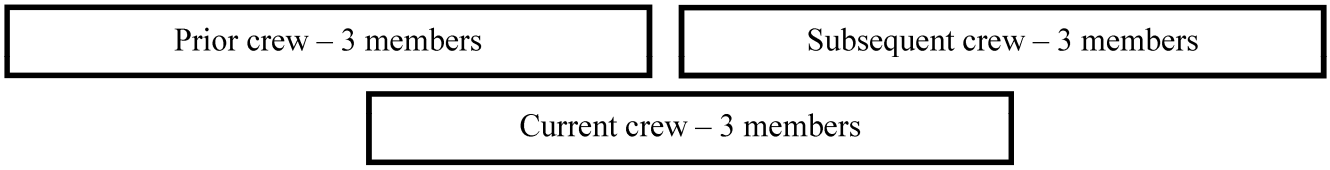

Figure 1. The approximate ISS crew rotation arrangement for the period from July 2011 to April 2020.

The crews of different ships were at the station together for about 2–3 months. Then, there was a change in the composition—the prime crew left the station, and, after a short period, the next one arrived; so, again, 2 crews worked in parallel. The frequent and most typical organization of the mission can be considered as follows: Duration—about 6 months; the Soyuz crew of 3 people arrives at the station, where the previous crew of 3 people is already located. After some period (on average, 1–2 months), the rotation takes place, and the next crew of 3 people arrives at the station. As a rule, two or three Russians and the rest of the crew, representing other space agencies, NASA, ESA, JAXA, and CSA, are on board the ISS at the same time. For example, ten Russian cosmonauts (one in each expedition), thirteen NASA astronauts (including three women), three representatives of the European Space Agency, and one each from Japan, Canada, and the United Arab Emirates, participated in ISS 52–62 missions.

This ideal scheme sometimes changes due to various events and emergency situations (such as cargo ship accidents). But, in general, most of the expeditions were at the station for 5.5–6 months, of which the first half, each crew co-existed with one crew and, during the second half, with another one. It is also important to note that each 3-man crew was trained for the flight, mostly separately from their future companions. Such an organization of the flights, of course, complicated the interactions in the joint expedition.

3.2. Tools

3.2.1. The PSPA (Personal Self-Perception and Attitudes)

The PSPA procedure [18] is a synthesis of the repertory grid technique based on G. Kelly's [19] theory of personality constructs and the Ch. Osgood semantic differential [20]. The methodology used in our research for constructing an individual "psychosemantic space" [21,22] allows us to study the dynamics of mutually perceived similarities/differences of the group members and, on this basis, to assess the level of interpersonal interaction and cohesion. Methods of psychosemantics and the construction of semantic spaces are often used, especially in cross-cultural studies [22,23]. They reveal "... semantic similarity and difference with the help of metric distance in n-dimensional space" [22]. This provides good opportunities for the study of mutual perception and value orientations in the professional group of cosmonauts.

The procedure based on the Bannister–Francella approach allows us to study how the crewmembers perceive each other. In the 1st stage, a subject participating in the study creates a list of 9 personages from his close social environment. We ask to include in the list the cosmonauts and astronauts with whom this cosmonaut intends to work on the ISS, as well as the MCC personnel. Three self-images are added to the selected people: Self-image in the present, past, and future (the ideal Self).

The 2nd stage includes the formation by each cosmonaut (not the researcher, as happens in the case of answering a standard psycho-social questionnaire) of the list of the criteria for assessing the previously chosen crewmates and himself as well. So, the cosmonaut formulates 12 pairs of criteria (constructs) for evaluating the personages, using

those properties that seem to him/her to be the most significant in describing people. The characteristics in the construct were supposed to be antonyms that would make it possible to compare most of the people being evaluated. Thus, in describing the social environment, participants rely on their internal psychological language and personal, rather than imposed, values, which significantly increases the accuracy of the method for assessing individual perception. This forms the individual repertory grid for the future evaluation.

From the characteristics proposed by the subject, 12 pairs of bipolar scales are formed. In the 3rd stage, the personages are rated on bipolar visual analog scales formed by 12 pairs of evaluation criteria (constructs). The 1st and 2nd stages were performed only in the pre-flight period; the 3rd stage was carried out before the flight on board the ISS and in the post-flight examination.

3.2.2. The PVQ and the Subjective Vitality Measurement

During the ISS-45–ISS-55 missions, to assess the influence of cultural factors, the CULT questionnaire was used, aimed at studying the astronauts' value system, decision-making style, leadership, and error management. The CULT questionnaire consists of 59 items and includes questions that had previously been used in numerous European psychological studies, as well as a short form of the classic PVQ ("Portrait of Values") by S. Schwartz [14]. Currently, the short-form PVQ, as well as the Subjective Vitality Questionnaire [24], are used only in the pre-flight and post-flight stages. In this paper, these results are not presented.

3.3. The PSPA Data Analysis

3.3.1. Factor Analysis of Primary Ratings

The PSPA software processes the subject's primary rating matrix using factor analysis (principal component method) in order to determine the position of each personage in a multidimensional diagram of the construct (criteria) and then to build and visualize them as a two-dimensional grid. The columns of the primary assessment grid correspond to the constructs (assessment criteria); the rows correspond to the personages being assessed. The comparative weight of each factor (principal component), the comparative weight of the constructs' factor loadings (see Table 1 below) for the first two factors (covering 86% of the variance of estimates), as well as projections of factor assessments on the axes of the first two principal components, are calculated automatically. According to Bannister and Francella [21] and preliminary results from the "Interaction-Attitudes" [16] space experiment, an increase in the weight of the 1st factor may be indicative of interpersonal tension and relationship problems.

Table 1. Example of selecting constructs for content analysis.

	Constructs Included in the Factor
11	curious—0.647 *—41%—static
12	dreamer—0.475 *—22%—realistic
06	smart—0.409 *—16%—fool
03	beginner——0.228—5%—experienced
04	funny—0.222—4%—boring
09	clever—0.220—4%—stupid

Note: *—a significant factor load of the criterion (construct).

3.3.2. Content Analysis of Interpersonal Perception Criteria

To analyze the content of interpersonal assessments that are part of the 1st and 2nd main components (factors), the lists of bipolar criteria (constructs) were compiled. For this purpose, three constructs with the most significant factor loadings (or correlation with the factor axes) were selected as part of the 1st and 2nd factors. Factor loadings (positive and negative) bigger than 0.3 [25] are considered significant and, thus, psychologically meaningful. So, for a sample of 24 cosmonauts whose flight lasted at least 6 months, each

list included about 72 criteria (24 × 3). An example of criteria selection for content analysis is presented in Table 1.

Content analysis was carried out by the expert assessments. The procedure involved three experts who independently assigned each construct to one of the 12 categories of values classified by S. Schwartz [26]. Expert assessments coincided by about 90%.

3.3.3. Analysis of Perceived "Psychological Similarity"

The PSPA software allows us to visualize the position of 12 personages in the form of a two-dimensional grid. The results of each test contain projections of variables (personages) on the axes of the first two principal components (personal values) (See Figure 2). According to the empirical data, in most cases, the first two factors dominate the structure of the subject's assessments, contributing to at least 70% of the dispersion of assessments, and they have a stable semantic composition.

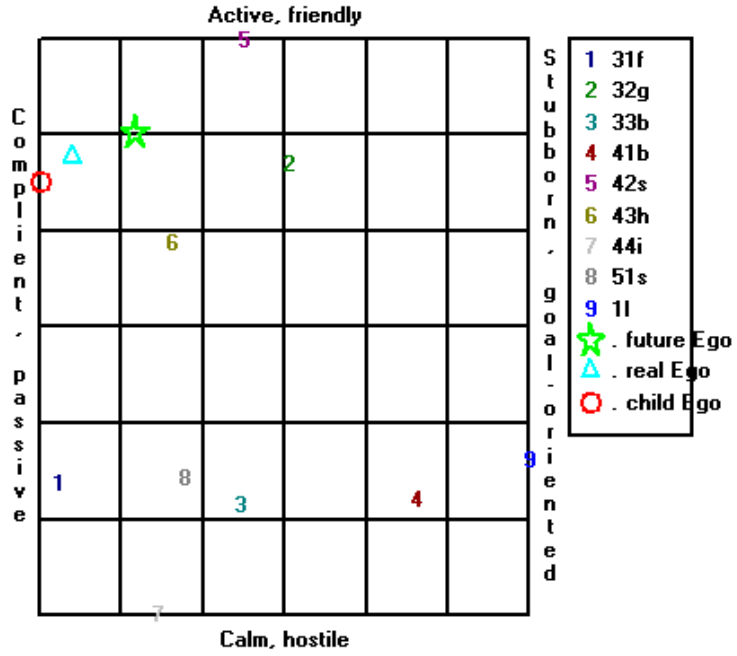

Figure 2. Example of the PSPA results: a chart of personages' positions in two-dimensional psychosemantic space, corresponding to the extent of "psychological similarity" of the subject's self-images (present, past, future) with other members of the group.

To assess the "psychological similarity", the distance between the personages and the subject's self-perception in the present, past, and future in the semantic space of 2 factors are calculated (in Likert scale points from −20 to 20). The structure of the self-image (the distances between the real Self, the ideal Self, and the child Self) is an important diagnostic feature. So, large differences between the ideal (future) Self and the real Self reflect the increased demands on one's Self and others. The close distances between the real Self and the child Self may signal some infantilism and immaturity of the subject.

Comparison of the personage with the image of the real Self and the ideal, aimed at assessing the perceived similarity/difference with other members of the professional group (international space crew), provides a study of the perception of social distances, which are determined by differences in national cultures [27].

3.3.4. Statistical Methods

To analyze the statistical reliability of the results, non-parametric methods were used: Wilcoxon's T-test (to evaluate changes in the studied variables) and Spearman's correlation coefficient, ρ. The correlation analysis of the variables described above, automatically calculated by the PSPA software, was carried out using SPSS Statistics 22.

4. Results

The application of the PSPA methodology on board the ISS made it possible to study changes in interpersonal perception at the different stages of a long-term space flight, as well as to evaluate the effects of changes in the crew's composition due to its rotation.

4.1. Group Dynamics under the Long-Term Space Flight Factors

4.1.1. The Relationship between the Crewmembers in the Course of Annual Space Flight

As part of the "Interaction-2" first phase, we analyzed group dynamics during a unique mission that lasted for two crewmembers for 340 days. It helped to pinpoint a number of new questions related to the crew selection for ultra-long missions. The data on the interpersonal perception of six members from various expeditions (ISS 43–44 to ISS 46–47), who were together with the annual expedition crew at the station during shorter periods of time, were studied.

To analyze the interpersonal interactions, we have chosen the parameters that reflect the "psychological similarity" or, on the contrary, "diversity" between the ISS crewmembers. Firstly, these are the distances between three different self-images: (1) the distance between the images of one's own ideal Self (me in the future) and the real Self; (2) the distance between the images of one's own real Self and Self in the past (childhood). Secondly, we analyzed the distances between the image of the real Self and the images of other crewmembers. To maintain the confidentiality of the results, we assigned subjects random codes: A, B, C, D, E, and F.

The dynamics of the following variables were analyzed: (1) the distance between the image of the real Self of each of five other cosmonauts (B, C, D, E, and F) and their image of subject A; (2) the distance between the image of the real Self of each of five other cosmonauts (A, C, D, E, and F) and their image of subject B, and so on (five variables for each of the six subjects). The same distances (five variables for each of the six subjects) were used for the image of the ideal Self. The list of variables also included the "Weight of 1st factor", which represented the degree of integration/differentiation (complexity) of the subjects' assessment system.

For three subjects (B, D, and F), the distances between the real Self and ideal Self of the other cosmonauts and their perception of images of B, D, and F had a significant correlation (see Table 2). Spearman's correlation coefficient, ρ, for subject B is 0.769 ($p = 0.01$), and for subject D, ρ = 0.713 ($p = 0.01$); for subject F, ρ = 0.634 ($p = 0.05$). For the other three subjects, the correlations were not significant.

The detected positive statistically significant correlation between the images of subjects B, D, and F and the real Self of all the other subjects may indicate that they were currently regarded as psychologically close, i.e., similar. Moreover, they were regarded not just as similar but as close to the ideal Selves of the other subjects.

For two subjects (A and D), significant negative correlations were obtained, testifying about the opposite tendency in group dynamics. Spearman's ρ between the ideal Self and perceived images of the other five subjects is -0.669, and $p = 0.05$. For the distances between the real Self of the other five participants and the perceived images of subjects A and D, ρ = -0.593, and $p = 0.05$. The presence of a significant negative relationship between the indicated parameters indicates that most of the crew perceived these two subjects as psychologically different. This can be regarded as an alienation process, according to Kanas [4].

Table 2. Correlations within some of the PSPA indices and with quantitative indicator of the crew communications with MCC—Confrontation.

Variable 1	Variable 2	Spearman's Correlation	Significance Level
Distance between real Self of other subjects and their image of subj. A	Distance between ideal Self of other subjects and their image of subj. A	0.252	0.257
Distance between real Self of other subjects and their image of subj. B	Distance between ideal Self of other subjects and their image of subj. B	0.769 **	0.000
Distance between real Self of other subjects and their image of subj. C	Distance between ideal Self of other subjects and their image of subj. C	0.018	0.890
Distance between real Self of other subjects and their image of subj. D	Distance between ideal Self of other subjects and their image of subj. D	0.713 **	0.000
Distance between real Self of other subjects and their image of subj. E	Distance between ideal Self of other subjects and their image of subj. E	−0.119	0.469
Distance between real Self of other subjects and their image of subj. F	Distance between ideal Self of other subjects and their image of subj. F	0.634 *	0.027
Distance between real Self of other subjects and their image of subj. A	Distance between real Self of other subjects and their image of subj. D	−0.593 **	0.003
Distance between ideal Self of other subjects and their image of subj. A	Distance between ideal Self of other subjects and their image of subj. D	−0.669 **	0.000
Confrontation with MCC	Distance between real Self and ideal Self	0.333 **	0.008
Confrontation with MCC	Weight of 1st factor	0.301 *	0.017

Notes: *—Correlation is significant, $p \leq 0.05$ (2-tailed); **—Correlation is significant, $p \leq 0.01$ (2-tailed).

4.1.2. Correlations with the Data of the Space Experiment "Content"

We also carried out a correlation analysis of the PSPA variables and some quantitative indicators obtained within the frame of another parallel Russian space experiment's "Content", where crew communication with the MCC was studied [28,29].

Significant positive correlations were found between the increase of the communication content category "Confrontation in communications with the MCC" and the rise of the PSPA variables "Weight of 1st factor" ($\rho = 0.301$, $p = 0.05$), testifying about the simplification of the social perception (black and white vision) and "The distance between the ideal Self and the real Self" ($\rho = 0.333$, $p = 0.01$). This can indicate that the increase in confrontation during the crew's communication with the MCC is significantly associated with both the simplification of the assessment system and the increase in the gap between what I am (the real Self) and what I want to be (the ideal Self). The data obtained show that these trends in the flight participant's interpersonal perception dynamics may be a sign of some psychological problems in the crew, which manifests itself in confrontation with the MCC as an opportunity to transfer negative emotions outward [4].

The presented results show the importance of analyzing interpersonal perception dynamics as the independent information source in the course of ultra-long flights for the purpose of assessing the interactions within the crew.

4.2. Analysis of Perceived "Psychological Similarity" with Other Crewmembers

An individual's perception of the crewmates demonstrates the degree of his/her identification with the group, psychological similarity, or, conversely, diversity, which is related to the level of group cohesion [12,30]. As we indicated above, the composition of the ISS missions in 2015–2020 was a combination of two separate crews arriving at the station at different times with transport ships.

In order to understand the impact of nationality on the perception of others under space flight, we analyzed the similarities and differences in the cosmonauts' perceptions of their compatriots and foreigners, mostly representatives from NASA in the ISS Missions

52–62 (Table 3). Russians' perceptions of the crewmembers from other agencies are not described here due to the small sample size.

Table 3. The number of crewmembers (Russians and NASA representatives) from ISS missions 52–62 included in the PSPA list of personages.

The Subgroup, Assessed by the Subjects	Number of Crewmembers
Russians from the subject's crew	-
Russians from the prior crew	8
Russians from the subsequent crew	9
NASA astronauts from the subject's crew	11
NASA astronauts from the prior crew	10
NASA astronauts from the subsequent crew	9

Figures 3 and 4 demonstrate mean group data on the psychological distance between the perceptions of the real Self, the ideal Self, and the other crewmembers: Russians from the prior crew, Russians from the subsequent crew, and NASA astronauts from their own crew.

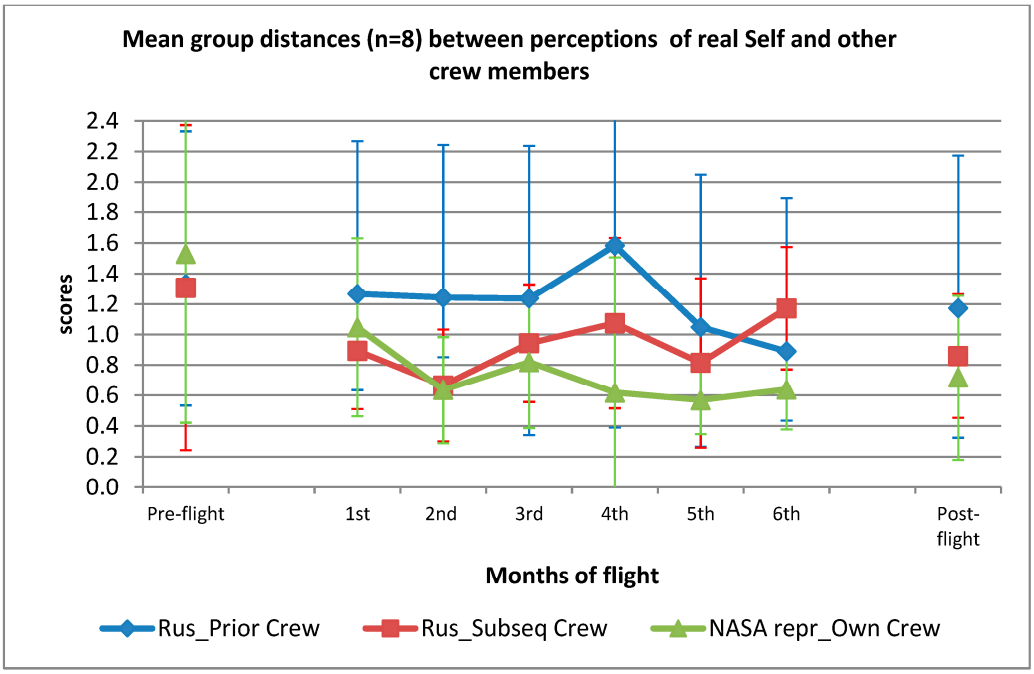

Figure 3. Dynamics of perceived similarity: average data for a group of cosmonauts (n = 8) during space flight (estimations of distances with the real Self).

We can see that, on average, the cosmonauts perceived the NASA representatives from their crew as more psychologically close than the Russians from the other crews. This can be regarded as a result of identification with their own group, supported by continuous joint training within their Soyuz crew. The most interesting thing is that the Russians from the prior crew are perceived by the cosmonauts from the subsequent crew as more psychologically "distant" from their real Self than the other two categories of the subjects (Russians and Americans). However, the Russians from the subsequent crew are also perceived as slightly more different starting from the 4th month of the flight (when they were really already present on board). For the ideal Self (Figure 4), in general, a similar picture was observed (except for the pre-flight and the first month of flight sessions).

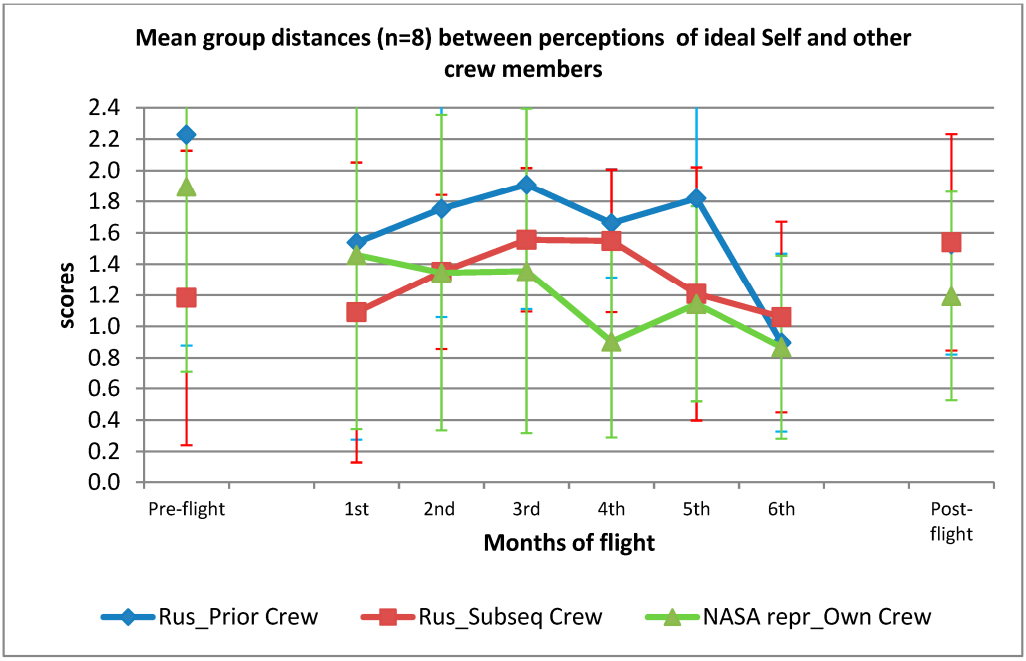

Figure 4. Dynamics of perceived similarity: average data for a group of cosmonauts (n = 8) during space flight (estimations of distances with the ideal Self).

In the 6th month of the flight, all these differences tended to smooth out.

It is important that such a perception pattern is kept even when the prime crew has already departed (see 3–5 months of flight), while the perception of newly arrived Russians changes, and they are perceived as slightly more distant and less ideal (4–5 months of flight). In the post-flight session, the American astronauts (members of their own crew) were also perceived as psychologically closer, more similar, and more ideal than Russians from other subgroups of the ISS's main expedition crew.

4.3. Dynamics of the Values Hierarchy (Significance of Professionally Important Traits) during Space Flight

Using the content analysis procedure, the significant criteria of the cosmonaut's interpersonal perception were assigned to different categories, composing the 1st and 2nd factors according to Schwartz's values classification [26]. For the content analysis, the data from twenty-four cosmonauts, whose duration of stay at the station was at least 6 months, were selected (the remaining six subjects had a shorter flight duration). The change in the significance of the values was analyzed separately for the 1st and 2nd factors (principal components), representing the two main meaningful axes of personal psychosemantic space [22]. At the same time, naturally, the 1st factor, which contains a major proportion of the variance in the subject's assessments (on average, 40–60%), is more significant for the analysis of the dynamics than the 2nd factor, which covers about 10–25% of this variance.

Figure 5 demonstrates the changes in the categories ratio among the significant criteria of interpersonal perception, which form the 1st factor after the flight, compared with the baseline (pre-flight). We can conclude that there are pronounced dynamics in two categories (Benevolence and Enjoyment). At the same time, it should be noted that Benevolence, after the flight, takes 2nd place in the hierarchy (after Conformity), and Enjoyment is in the last place.

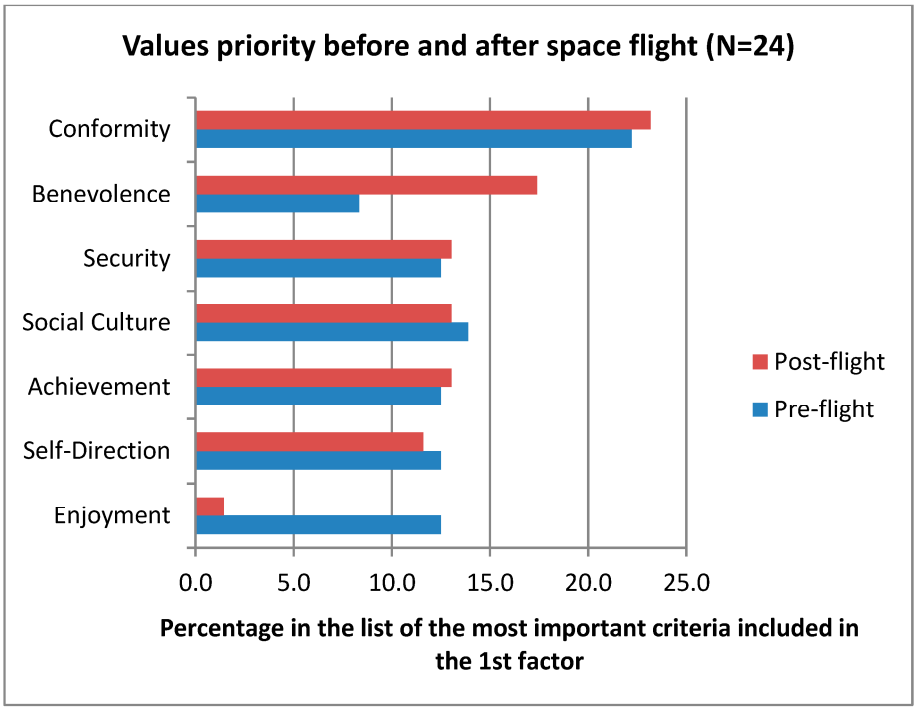

Figure 5. Comparison of the values with a higher weight, composing the 1st factor before and after the flight.

Figure 6 presents the data for these two categories obtained during the flight. We can see that the most obvious changes occurred in the first month of the flight, compared to the pre-flight period. For Benevolence, an increase in the percentage in the list of important criteria is statistically significant ($p = 0.01$, according to the Wilcoxon test). For Enjoyment, the decrease in the percentage in the list of criteria for the first month of the flight, compared to the period before the flight, does not reach the statistical significance level.

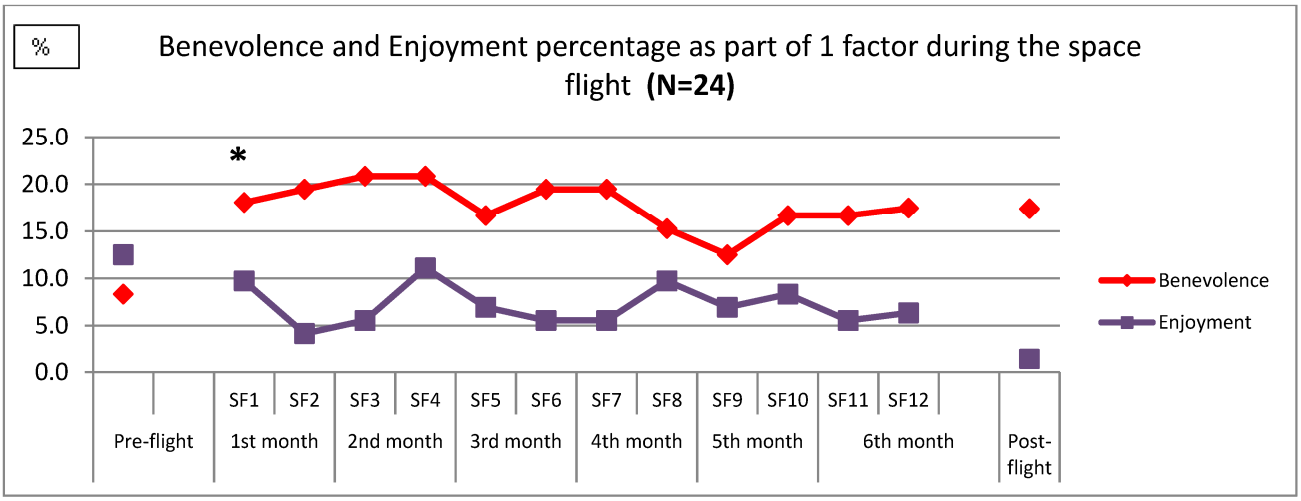

Figure 6. Changes in the percentage of the categories Benevolence and Enjoyment (as a part of the 1st factor) during the space flight. *—The increase in percentage of Benevolence is statistically significant ($p = 0.01$, according to the Wilcoxon test).

Figures 7 and 8 present similar data for the 2nd factor. The evident changes in the categories of Self-Direction, Social Culture, and Stimulation were detected; however, they did not reach statistical significance. So, we can only speak about the trends in the changes in the importance of these values.

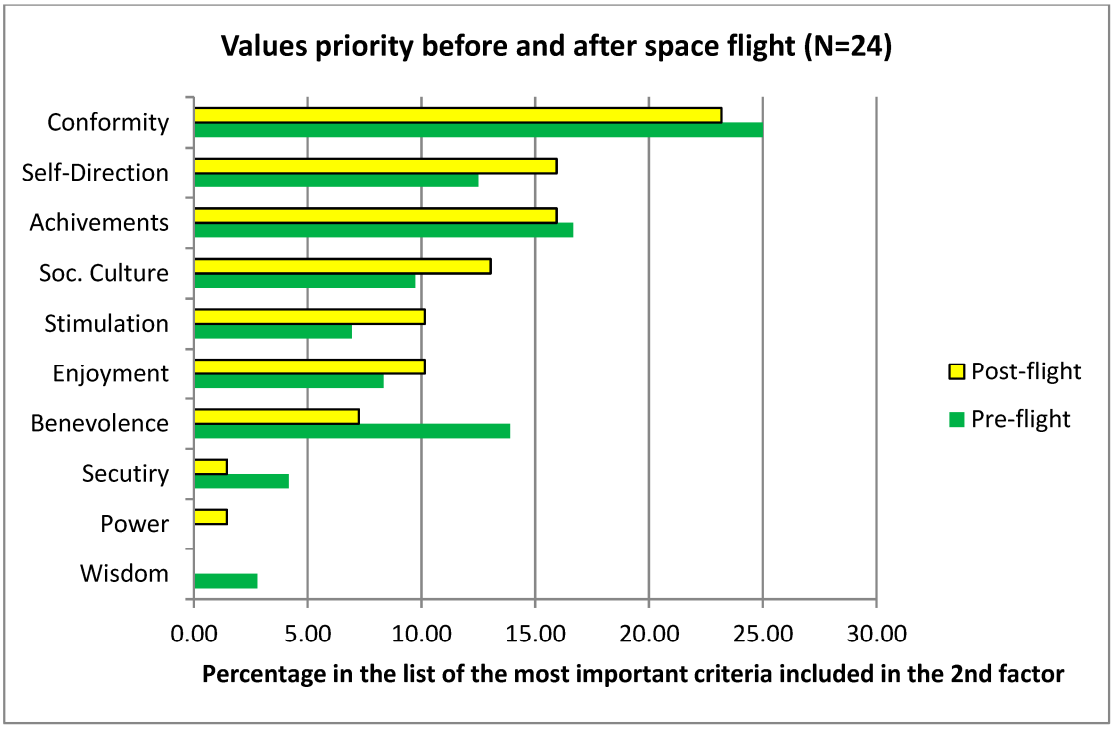

Figure 7. Comparison of the values with a higher weight, composing the 2nd factor before and after the flight.

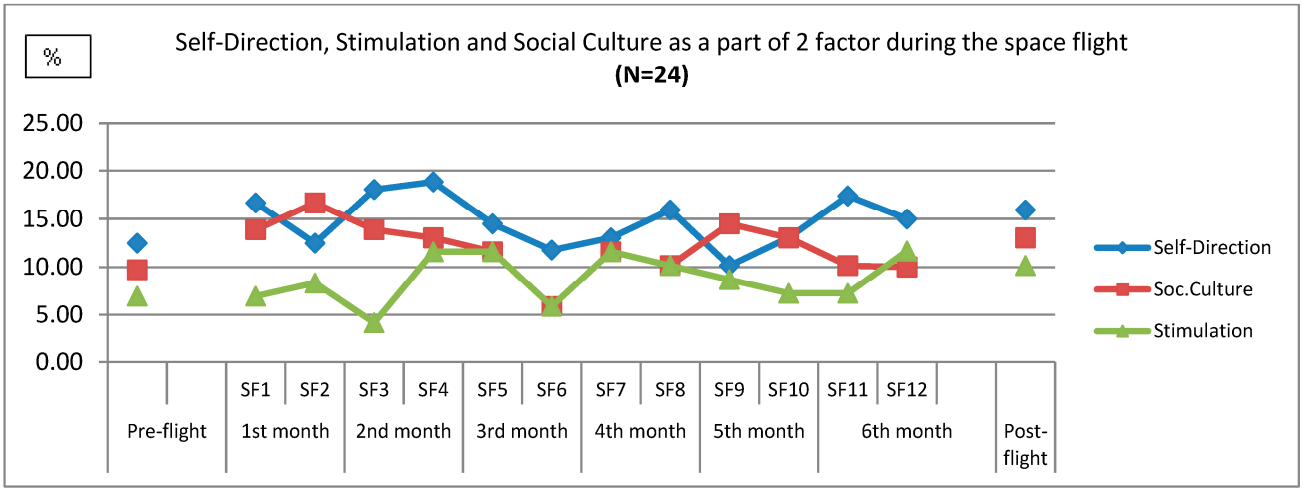

Figure 8. Changes in the percentage of the categories Self-Direction, Social Culture, and Stimulation (as a part of the 2nd factor) during the space flight.

The content analysis of the cosmonauts' values, composing the 1st and 2nd factors, were permitted to define the so-called professionally important personal traits, which are important for the members of the astronauts' core to execute their tasks under space stress. Therefore, the growth of the importance of Benevolence (sociability, sensitivity, sympathy, and support, as opposed to selfishness, indifference, and hostility) during the first, most difficult period of the flight can be regarded as an effective coping strategy to deal with the effects of extreme factors. On the other hand, the decrease in Enjoyment, the pleasures of life, is also a part of the values' natural adaptive restructuring due to the threat to life and health, as well as the increase of physical discomfort experienced by the cosmonauts on board.

The content analysis of the 2nd factor's values revealed the increase of significance of Self-Direction (independence, intelligence, and curiosity), Stimulation (the novelty of sen-

sations, challenges, and risk), and Social Culture (ability to avoid excesses in relationships, communication skills, and modesty). This can also be considered as the signs of normal adaptation in a small professional group working in isolation and confinement.

At the same time, it should be emphasized that the most significant value throughout the entire space flight was Conformity, which includes such traits as politeness, good manners, self-discipline, neatness, accuracy, diligence, and commitment. These qualities reflect the prime orientation of the cosmonauts at the accomplishment of the flight protocol, in accordance with rules and regulations, and a good relationship with the other crewmembers and the MCC. Personal qualities, representing the Achievements category—ambition, purposefulness, social recognition, and success—on average, were not so significant in the group of cosmonauts (they were in 3–5 places in terms of percentage).

5. Discussion

The analysis of the cosmonauts' perception during the period of the annual flight revealed certain problems with cohesion, which could be explained by the subgrouping that was "embedded" by the existence of separate small crews arriving at the station at different times and undergoing a different crew training schedule.

The content analysis of the criteria self-created by the Russian cosmonauts for assessing their close environment made it possible to describe the dynamics of the values hierarchy under the influence of extended space flight factors. The increase in the weight of such values as Benevolence, Self-Direction, and Stimulation, and the decrease in the importance of Enjoyment and Achievements during the flight correspond to previously gained data by N. Kanas and can be regarded as the result of successful crew adaptation as a team [3]. Personal qualities representing the Achievements category—ambition, purposefulness, social recognition, and success—on average, did not occupy such a significant place among the values of the cosmonauts, which is somewhat different from P. Suedfeld's data obtained for American astronauts [13,31,32], although he also observed some decrease in their importance after participation in space flight. In general, we suppose that the revealed changes in the hierarchy of the values among the Russian cosmonauts can be characterized as a necessary adaptation to the requirements for life and work inside a small professional crew in stressful space flight conditions.

The defined increase in psychological "distances" with the MCC representatives, together with the signs of confrontation in the crew's communication with Earth, may indicate the rise of the individual psychological discomfort in cosmonauts, as well as the interaction problems in the crew, which require the transfer of negative emotions on the external interlocutors—a phenomenon that has been repeatedly described for isolated groups [29,33].

Within the frame of our study, we found out that the cosmonauts perceived the incoming crew as psychologically different from themselves. This phenomenon of perception of the colleagues from the prior crew as more psychologically different (strangers) from themselves and the NASA astronauts from their own crew or even the Russians from the subsequent (next to them) crew, who were not yet in the station, can be explained by the well-known "host - guest" problem [5]. Probably, the incoming novices regard the already adapted colleagues from the prior crew as experienced "hosts" of the station. So, they have to take the different social role of the penetrating "guest", arriving at the owners' territory, at least for the period of their adaptation. This perception pattern remained stable even after the prior crew left the ISS.

Taking into account the possible long-term autonomous space missions and the extension of the operator tasks' difficulty, it becomes very important to obtain new data on the crewmembers' interaction effectiveness in the course of joint activities, such as the operations on the Moon or on another planet's surface. For this purpose, we added to our methodology the investigations by aid of the "Homeostat" device [34,35], which simulated the tasks requiring joint actions. It is an instrumental group technique, successfully tested both in numerous ground-based analog studies and for the selection of cosmonauts in the

1960s [36]. Its predictive power was highly appreciated by ESA and NASA experts [37,38]. The start of this research on board the ISS is planned for autumn 2023.

6. Conclusions

The presented results of the "Interaction-2" space experiment showed the possibility of studying, through the assessment of the cosmonauts' interpersonal perceptions, the relationship between crewmembers belonging to different ISS expeditions and representing different national agencies.

The study of psychological similarity and its dynamics during the flight provides information about the changes in the cohesion of multicultural ISS crews. The dynamics of psychological "distances" (the perceived similarity/difference between the real Self or the ideal Self and the images of other flight participants) represent the peculiarities of interaction and cohesion in the different stages of space flight.

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