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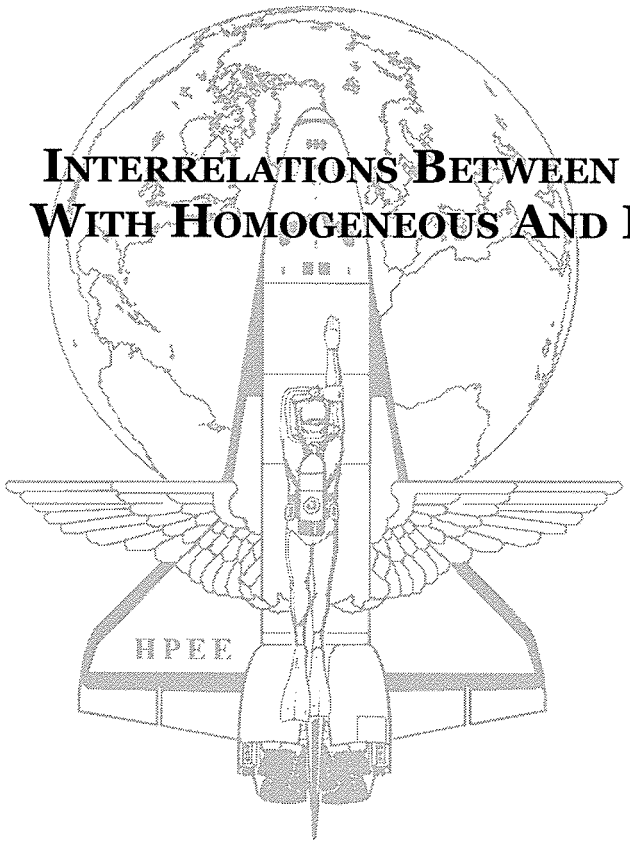

INTERRELATIONS BETWEEN THE SMALL ISOLATED GROUPS WITH HOMOGENEOUS AND HETEROGENEOUS COMPOSITION

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ABSTRACT
Introduction. Increase in the heterogeneity of a space crew's composition (cultural and gender differences) is a risk factor that can negatively influence the formation of a cohesive crew, which depends on a common way of perceiving one's social environment, goals and values. **Method**. Three groups working in isolation from 110 to 240 days, all with different cultural and gender composition were analysed using a modification of Kelly's repertory grid technique during a space simulation at the Institute for Biomedical Problems, Moscow. Subjects assessed themselves and each other monthly. **Results**. National Russian and international groups failed to create a single cohesive crew. Members of both groups considered people from their group as "us" and their neighbours as "them". Their relations became more negative during the mission, with attitudes changing from neutral to poor. Subjects began to perceive each other as "different and distant". Cultural and language differences prevented national (Russian) and international groups from forming a common understanding of behavioural rules and establishing close emotional contacts. **Conclusions**. Differences in perception of the interpersonal environment, group goals and values in national and international groups hindered the formation of a joint cohesive crew.

Problems in inter-group interaction between crews (prime and visiting crews) staying simultaneously onboard a space vehicle were detected for the first time during extended space flights of Russian stations "Salyut" and "Soyuz" (1,3,17). Several times the prime crew, playing the role of "hospitable hosts", had to postpone the execution of their flight program in order to help the visitors, who had not yet adapted to the unfavourable aspects of space flight (4, 17). The "host-guest" situation sometimes caused violations in the execution of the flight program and, in some cases, increased tension between crews (16). During Shuttle/Mir space missions, this interaction problem expressed itself in a different way. Astronauts reported more dissatisfaction with their interpersonal environment than their Russian colleagues in a number of mood and group measures (12, 13).

In space simulation studies (e.g. in the 90-day isolation project called ECOPSY) similar psychological problems expressed themselves even more vividly. The prime crew reported several times that the visiting crew interfered with their execution of the scientific protocol and blamed them for not being better prepared. At the same time, visitors noticed the decrease in sociability of the prime crew (4).

In the International Space Station (ISS), astronauts and cosmonauts, although living and working in different national modules and having different flight experience, have to form one joint international crew. They will have joint flight protocols and, at the same time, will fulfil a number of different tasks in accordance with their national flight programs. This allows us to predict that the above-mentioned problems could become important, especially due to the increased heterogeneity of the ISS crews compositions (1, 6, 8, 11-

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13, 16, 18-20, 22, 24, 25).

In a previous study, we demonstrated that optimal crew interactions and the achievement of mission goals are dependent upon the ability of the crewmembers to perceive each other accurately (4, 5, 16). In the ground-based space simulation mission, SFINCSS'99, addressed in this paper, the objective was to study inter-group relations with the aim of generalising the findings to actual ISS missions, and for this two hypotheses were tested. According to the first one, the increase in the heterogeneity of crew composition (cultural and gender differences) is a risk factor that can negatively influence the formation of a single cohesive crew. The objective of this article was the comparative analysis of relation changes between groups, varying in national and gender composition, staying together under confinement. The second hypothesis was that the existence of a common way of perceiving one's interpersonal environment, goals and values are key factors in the formation of joint cohesive crews. We suppose that these differences could negatively influence relations between subgroups and could form the basis for the conflict tension between them. Therefore a special focus of the study examined existing differences in the group's internal culture, subjects' beliefs and values.

In this article we are trying to present only general data, describing relations between the groups and our investigation of some possible roots and background for the conflict that occurred. A more detailed description of the relations in Group 3 (whose composition is mostly similar to ISS crews) as well as conflict details and behavior deserve a separate article in preparation now.

METHODS

Setting

The studies were made within the framework of an international experiment involving prolonged isolation in hermetic chambers, called SFINCSS-99 (Simulation of Flight of International Crew on Space Station). The main objective of SFINCSS-99 was the gathering of experimental data about the influence of extended isolation in a hermetic chamber (simulating ISS flight conditions) on the in-flight and post-flight psycho-physiological status of astronauts. Investigators proposed to study two simultaneously functioning groups in a high fidelity simulation of an ISS flight.

Groups of subjects lived in two modules of the Institute for Biomedical Problems (IBMP) simulator, representing 100 and 200 cubic meters in volume, respectively. The two modules were connected by a tunnel, simulating ISS segmentation and giving the crews contact opportunities and ability to perform joint studies. In these hermetic chambers, environmental parameters (humidity, pressure, gas composition, temperature, and noise) corresponded to the Mir space station standards. The crews' schedules consisted of meaningful work (e.g., habitat maintenance, scientific experiments), physical training, recreation, and 8-h sleep comparable to the work/rest pattern on board the Mir station.

Subjects

The project planned to host three groups of four subjects each. Subjects from different countries were expected to enter the experimental setting as prime and visiting crewmembers. The first group (4 Russian males, age from 37 to 48) spent 240 days in the small chamber (100 cubic meters) and lived and worked in accordance with the standard daily schedule of the Mir space station, with a work period of approximately 8 hours.

The second group (4 males, age from 27 to 45 - 3 Russians and a German Commander) spent 110 days in isolation in the second chamber (200 cubic meters), entering the experimental setting 21 days after the start of the project. This group worked according to a more intensive daily schedule due to more physical training, similar to that expected for the early utilisation phase of ISS. These conditions allowed investigators to simulate possible discrepancies in national flight programs and pre-empt difficult situations in crew interaction.

The third group (consisted of 3 males from Austria, Japan and Russia and a Canadian female, age from 27 to 37) started their 110 days tenure 22 days after the second group left Chamber 2. Their work regime was similar to that of Group 2, except that Group 3 had more flexibility in planning in their daily schedule; were informed about the total amount of work expected of them on a daily basis; and were permitted to portion their time according to their wishes.

There were three visiting crews (Groups 4, 5, 6), composed of 3 to 7 persons each who resided with the resident crew in Chamber 2. The duration of the visiting crew stays were 4-7 days.

The flow of experiments were disturbed for 1 month, when as a consequence of conflict between Groups 1 and 3 the transfer hatch between the chambers was closed. At the moment of conflict Group 1 had already spent 6 months under isolation, Group 3 – about 3 weeks. This conflict included 2 events: an incident, involving physical force between Russian members of Groups 1 and 3 and another incident, involving a subject from Group 1 trying to kiss the female subject from Group 3. Closing of the hatch made fulfillment of some experiments from the Mission schedule impossible because the appropriate equipment became unavailable for the subjects from both groups. Additionally, a member from Group 3 left the chamber earlier (after 2 months of isolation) than scheduled due to the aforementioned conflict.

Instruments

As in previous space simulation studies, we used a system of subjective attitude analysis based on the semantic differential approach of Osgood and Kelly's repertory grid technique in order to assess crewmembers' perceptions of each other (2, 4, 5, 14). This system uses bipolar scales anchored by pairs of opposite criteria (constructs) that are provided by the subjects, not by the experimenters. The main advantage of this approach is that by using their own inner psychological language, the subjects can make precise assessments that are closer to their real perception of themselves and other people. The only requirement is that each pair of traits has to give the subjects the ability to differentiate the majority of the people being assessed.

By this method, subjects evaluate "personages" (i.e., themselves and other people) based on these bipolar scales, and a factor analysis is used to determine the position of each personage in a multidimensional diagram of constructs, which can be plotted and visualised spatially in a two-dimensional grid. From these results, the subjects' estimates of themselves and of others whom they regard either as similar (i.e., closer in this space) or different can be determined (2, 4, 5, 14). Changes over time in subject's self-appraisal represent peculiarities of their personality, and the dynamics of their perception of themselves and others reflect their changing position in the group (4, 5).

Procedures

Each subject had to select a group of 12 personages, including crewmembers and his or her ego-image (23) in the past (i.e., childhood), present and future (i.e., his ideal ego). For the first (baseline) estimation, the subject chose important people in his life with whom he closely interacted with in his immediate interpersonal environment as personages. Then each subject devised 12 pairs of assessment criteria for the selected personages by using traits, which were crucial to his attitudes toward people. Finally, the subject assessed the personages using his own criteria. In the experiment he (or she) changed only the list of personages: instead of relatives and friends, the subject began to assess his crewmembers. This was repeated once before isolation, monthly throughout isolation, and once during the debriefing, that occurred one week post-isolation. Each subject made the assessments via his personal computer using the previously selected lists of personages and criteria.

RESULTS

Analysis

PSPA is the original computerized program used to conduct a factor analysis (principal components method) of the subject's estimates of themselves and of others, in order to determine the position of each personage in a multidimensional diagram of constructs, and plot and visualise results spatially in a two-dimensional grid (15). We need to stress that the current version of software can process the data of only one test session of one subject per analysis. The columns of the initial matrix of subject's data correspond to the constructs (assessment criteria), created by the subject and the rows – to the estimated personages. The comparative weight of each factor (principal component), the comparative weight of factor loadings of the constructs for the two main factors, and the projection of the factor scores of the personages onto three principal components axes are calculated automatically. Using the criteria of an eigenvalue greater than or equal to 1.0 as the threshold for qualifying as a factor, the factors dimensions representing an individual's system of attitudes are determined for each subject at each time point.

Results of each testing session contain projections of the variables (personages) on the axes of the main components. The value of each variable projection (personage) and the coordinates of each personage's position in the two-dimensional space of the main components are calculated. These main components for each subject are chosen when those factors which meet eigenvalue criteria, i.e., dominate in the structure of the subject's assessments during isolation, contributing at least 70% to the variance of the variables and have rather stable semantic composition. When the comparative weight of other factors is much lower, and their semantic structure was not steady, they are dropped from the analysis.

The more the weight of the principal component, the more variation in the personages projections on the axis of each principal component. Therefore in order to make the interpretation of the results more convenient, the range of changes for each component was divided into six equal sections. So, on the grid the real personage positions are presented, but in relative units due to differences in axis length.

Rotation of the factor space was deemed unnecessary when gained

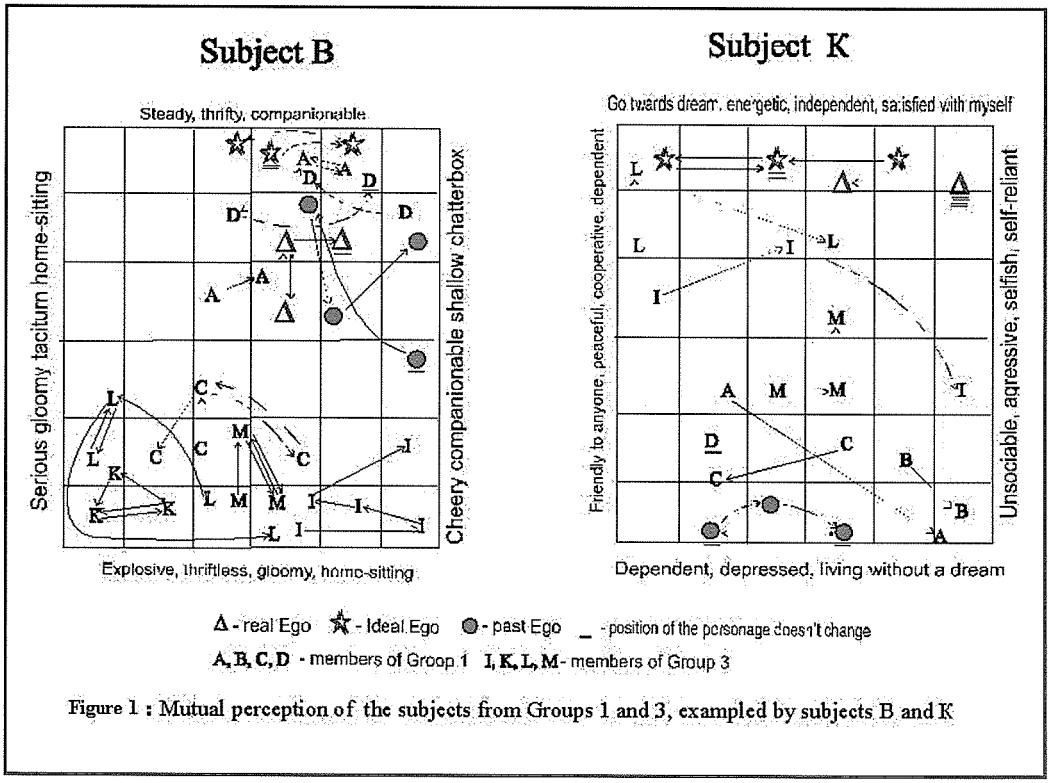

Figure 1 : Mutual perception of the subjects from Groups 1 and 3, exampled by subjects B and K

Figure 1. Mutual Perception of the Subjects from Groups 1 and 3, Exampled by Subjects B and K

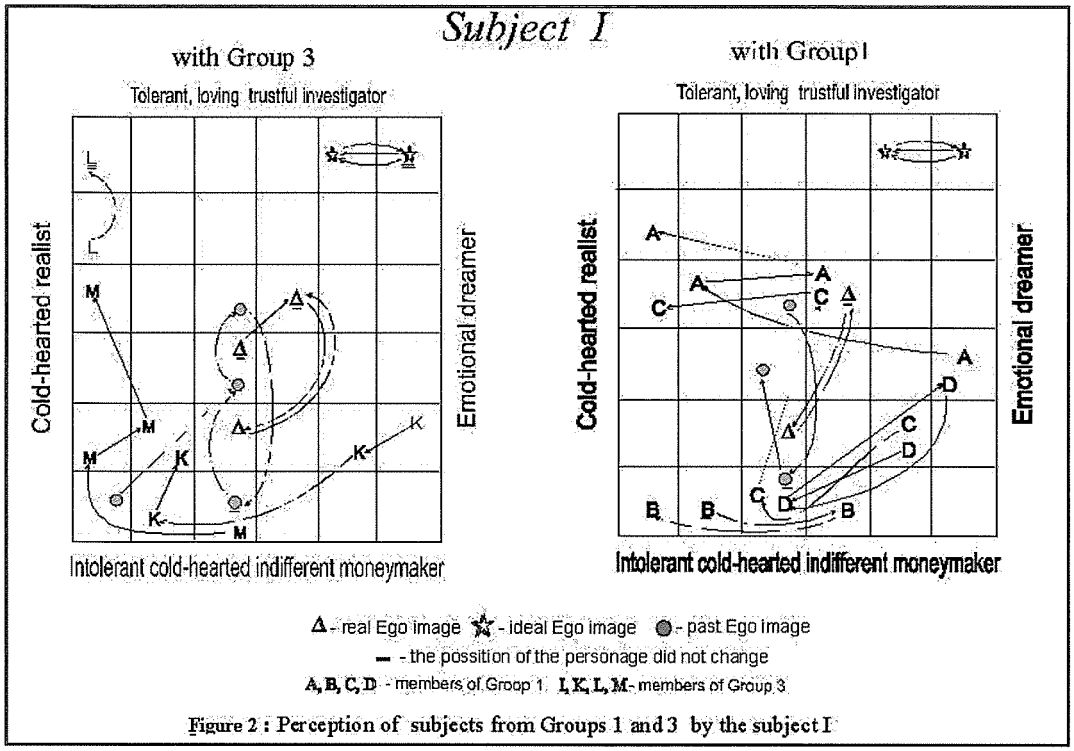

Figure 2. Perception of Subjects from Group 1 and 3 by Subject 1

results already gave a clear understanding of the process of subject's perception of his social environment. Standardization of the initial data was also not conducted, because all the variables represent scales of the same nature with the same range of change.

A two-dimensional grid of constructs is plotted manually, representing diagrams of the personages', i.e., the factor scores for the first two principal components, which describe the general structure of the attitudes for the subjects during the testing session. The results are presented in the figures as the position of the personages in the two-dimensional space of the described factors.

A manual analysis of dynamic changes of attitudes throughout the whole testing period was made. The first objective was to determine if the factor's structure (composition) is typical for the subject during the whole isolation period. For this purpose, analysis of the content of the principal components was made for the whole testing period. Since each factor consisted of several pairs of characteristics, only those whose contribution to the factor's weight was considerable (i.e., not less than 10%) were chosen. If a factor's composition was stable a joint two-dimensional grid was plotted, representing diagrams of the personages' factor scores for the first two principal components.

Thus dynamic changes of attitudes are presented as a projection of several testing sessions on the same grid. Arrows demonstrate the sequence of change of the position of each personage in the space of the two main factors during various stages of the mission. The starting point is the position of the personage which does not have an arrow directed to it. The closer the personage is to a pole of the factor, the more this criterion (or trait) is typical of him or her. Two personages that become relatively closer on the axis of a given bipolar factor indicate an increasing similarity on this factor. Relative closeness of personages on the axis of a given bipolar factor indicates their comparative similarity and psychological identity in a subject's perception. Vice versa, the longer the distance between personages, the bigger the difference between the perceived by subject. (Figures 1-2).

When the factor composition was not stable, several grids were

Table 1. A mutual assessment of Groups 1 and 2 (M±SD).

	Assessing group –1		Assessing group –2	
	Estimations of group 1	Estimations of group 2	Estimations of group 1	Estimations of group 2
Frequency of the positive estimations	0,438±0,042	0,775±0,034	0,413±0,185	0,617±0,192
Frequency of the neutral estimations	0,146±0,080	0,100±0,034	0,000±0,000	0,083±0,083
Frequency of the negative estimations	0,417±0,096	0,125±0,000	0,587±0,185	0,300±0,112
Estimation's frequency index (EFI).	0,021±0,125	0,650±0,034	-0,175±0,371	0,317±0,303

Table 2. Mutual assessments of Groups 1 and 3 before the conflict (M±SD).

	Assessing group -1		Assessing group -3	
	Estimations of group 1	Estimations of group 3	Estimations of group 1	Estimations of group 3
Frequency of the positive estimations	0,333±0,000	0,406±0,044	0,438±0,000	0,667±0,000
Frequency of the neutral estimations	0,333±0,000	0,063±0,000	0,000±0,000	0,166±0,118
Frequency of the negative estimations	0,333±0,000	0,531±0,044	0,562±0,000	0,167±0,118
Estimation's frequency index (EFI).	0,000±0,000	-0,125±0,063	-0,125±0,000	0,500±0,118

plotted for each testing period where they are steady.

Inter-group Attitudes

In order to attribute subject's attitude to his partners we analysed the distance between the position of a subject's present or future ego and the object (crewmember) on the factor's axis. If crewmember's position on the axis was close to the subject's present or future ego (not more than two cells on the axis), the attitude was regarded as positive. That means that the subject was regarding his partner as psychologically "close", "similar" to himself and/or his perception of his ideal. In contrast, if object's ego was far from subject's present or future ego, then this attitude was judged as negative. All other positions of the object were regarded as neutral.

The total number of the positive and negative marks for each subject and his group were calculated and presented as a matrix .We analysed frequencies of the positive, neutral and negative estimations given by subjects to the members of their own and neighbour groups during the four testing sessions under isolation. As an integral parameter we used difference between the number of positive and negative estimations during the mission to create an estimation frequency index (EFI). In order to evaluate significance of differences, ANOVA technique was utilised. Significance threshold was determined as 0.05.

Results of this interrelations study are presented on the Tables 1-3. Groups 1 and 2 both estimated Group 2 more positively than Group 1. Significance of EFI differences was $p<0.0001$ for Group 1 and $p=0.05$ for Group 2 (Table 1).

Tension between the Groups 1 and 3 finally were expressed in open conflict. This conflict caused, in particular, the closure of the hatch between the chambers upon the request of the Group 3 members. Therefore certain experiments requiring common utilisation of "Station's" space and resources were cancelled for about a month.

Before the conflict between Groups 1 and 3 (Table 2), Group 1 gave itself neutral evaluations, consistent with their self-estimation during the previous period of interaction with Group 2. At the same time there was slight negativism (not significant) in their attitude to Group 3. We also detected certain negativism in the attitude of Group 3 to Group 1. Simultaneously Group 3 estimated themselves positively. This difference was statistically significant ($p=0.042$).

After the conflict (Table 3), Group 1 began to estimate themselves more positive, and Group 3 more negative than before ($p=0.0017$). Group 3 maintained a negative attitude towards Group 1, but their self-estimation changed from positive to neutral. Differences in estimation of their own group and Group 1 became less drastic ($p=0.056$).

An example of how the subjects from the Groups 1 and 3 perceived each other are presented in Figure 1. The Figure demonstrates that there was a considerable difference (as shown by the distance between the groups within the semantic space) in the attitudes that the subjects had toward their own group versus attitudes they had toward their colleagues from another group.

What we found especially interesting, were the attitudes of the Russian member of the international group. Despite our expectations, he identified himself with members from both groups almost equally (Figure 2). In each group he had one subject, less preferable for him. An incident of physical force occurred with the one from national Russian group, i.e., Group 3. We also noticed a very close mutual relationship between him and subject K from his own group, which he didn't have in the Russian group (Figure 2).

Semantic Patterns in Groups

In order to study common semantic patterns, expressing group values, our experts divided all the original traits created by subjects, into seven categories in accordance with a classification proposed by Vinokhodova (26). They are: 1) performance traits, describing a subject's activity, experience, and skills; 2) cognitive traits, defining intellect and cognitive style; 3) moral and ethical traits; 4) emotional traits, characterising mood and emotional status; 5) social behavior traits, describing sociability, in-group behavior, communication skills; 6) self-appraisal traits, defining the level of self-acceptance, self-satisfaction; and 7) subjective estimations traits, showing if the object is pleasant or unpleasant to the subject. When we were attributing a trait, we took into consideration not only its particular meaning, but also the general meaning of the whole pattern of traits, which a factor contained. In some cases, it was diffi-

cult to attribute the trait to one particular category, so we used two categories for its classification. Then we calculated the number of the traits of each category used by each subject and the group as a whole. Semantic composition of the two main factors for each subject is presented on Table 4. Each cell of the table contains the number of criteria of the certain type, utilized by the subject.

Among the traits describing the attitudes of the Group 1 subjects, we detected 17 "performance" criteria, 8 "emotional" and "cognitive" ones, 12 characteristics of "social behavior", 5 "moral" and 1 referring to "subjective estimations". On average, the list of traits of the subjects from this group contained 4 "performance" criteria, 3 characteristics of "social behavior", 2 "emotional" and "cognitive" ones, and 1 "moral" criteria.

Among the traits, described by the attitudes of subjects from the Group 2, we found 13 "performance" and "social behavior" characteristics, 5 "emotional" and "moral" ones, 3 "cognitive" and "subjective estimations" criteria. On average, the list of traits of the subjects from this group contained 3.5 "performance" and "social behavior" traits, 1.5 "emotional" and "moral" ones and 1 "cognitive" and "subjective estimations" criteria.

The Group 3 subjects used 16 characteristics of "social behavior", 9 "performance" and 8 "emotional", 4 "moral" and "cognitive", and 1 "subjective estimations" and "self-appraisal" ones. In average, the list of traits of the subject from this group contained 4 criteria, describing "social behavior", 2 "performance", "cognitive", "moral" and "emotional" ones.

The semantic patterns of the Russian member of the international group were similar to the pattern of his group. Socio-emotional criteria (7) dominated in perceptions of his social environment.

DISCUSSION

In accordance with our first hypothesis, subjects from Groups 1 and 2 managed to form a joint cohesive crew despite different experiences, different durations of stay, somewhat different cultural composition. This conclusion is based on the numerous mutual positive marks that subjects from these groups gave to each other. We theorise that subjects from Group 1 initiated the groups' rapprochement. From the very beginning they perceived the majority of their partners from Group 2 positively (i.e. psychologically similar and close).

At the initial period of their Mission, Group 2 subjects perceived their neighbours as "different, not like us". This could be interpreted as the influence of the well-known "newcomer" ("host-guest") effect (16). However, the longer they stayed together, the more positive their attitude toward the Group 1 became (6 cases of the attitude improvement). But they didn't perceive Group 1 as positively as they perceived themselves.

Groups 1 and 3 failed to create a single cohesive crew. It is clear from the Figure 1 that members of both of these groups considered people from their group as "us", and their neighbours as "them". Moreover, the Group 1-3 relations became increasingly negative during the mission, attitudes changing from neutral to poor. The subjects began to perceive each other as "different and distant". This suggests alienation between the two groups. This could not be attributed to the "newcomer" effect, because we did not find evident signs of negativism between these groups at the initial stage of their joint stay in the chambers (first two weeks).

Cultural and gender differences appear to have influenced the causal attribution process (20), especially under time constraints for decision-making (1, 8, 10, 18, 20, 21). According to Myers (20), finding themselves inside a group from another culture, race or gender, people more clearly realise their differences and become sensitive as to how they are perceived. In this case, the lack of joint training of Groups 1 and 3 and the lack of knowledge about each other forced the subjects to rely not on their knowledge and experience but on social stereotypes and prejudices in their formation of opinions about their partners. We conclude that insufficient knowledge about cultural or gender differences that determine behavior of other crewmembers, could cause psychological tension in a group.

A content analysis of the elements of social perceiving systems (criteria) showed that in Group 1 operational orientation was crucial in determining their attitude toward people. For the subjects from this group, it was more important if their teammate was "pro-

Table 3. Mutual assessments of Groups 1 and 3 after the conflict (M±SD).

	Assessing group -1		Assessing group -3	
	Estimations of group 1	Estimations of group 3 *	Estimations of group 1	Estimations of group 3
Frequency of the positive estimations	0,583±0,000	0,229±0,036	0,361±0,096	0,361±0,048
Frequency of the neutral estimations	0,125±0,059	0,076±0,012	0,000±0,000	0,306±0,048
Frequency of the negative estimations	0,292±0,059	0,694±0,048	0,639±0,096	0,333±0,000
Estimation's frequency index (EFI).	0,291±0,059	0,465±0,084	-0,278±0,192	0,028±0,048

Table 4: Utilization of estimation categories by subjects from Group 1, 2 and 3

	Performance	Cognitive	Emotional	Moral & Ethics	Social Behavior	Self Appraisal	Subjective Estimations
A	4	2	1	-	3	-	-
B	5	2	5	-	3	-	-
C	3	5	1	3	2	-	-
D	5	1	1	1	6	-	-
Group Σ	17	10	8	4	14	0	0
E	1	1	1	-	5	-	-
F	2	2	-	2	3	-	-
G	6	-	3	2	2	-	-
H	4	-	1	1	2	-	2
Group Σ	13	3	5	5	12	0	2
I	3	1	1	2	5	-	-
K	3	-	1	-	4	1	-
L	1	1	4	-	5	-	1
M	2	2	3	1	2	-	1
Group Σ	9	4	9	3	16	1	2
Total Σ	39	17	22	12	42	1	4

fessional", "experienced" and "capable". In Group 3, the role of the "performance" criteria was twice as low. At the same time, characteristics of "social behavior" (sociability, communication skills) and the "emotional" sphere dominated in their estimation of their crewmates. In Group 2, we detected a balance of operational and social behavior criteria.

This interpretation of each group's criteria gives us more understanding of inter-group dynamics. We found that for Group 1, the key issue for establishing a close relationship with Group 2 was connected to their ability to jointly execute the mission protocol. After Group 1 subjects had confirmed that they could effectively work together with Group 2 subjects (during the short joint training and the first period of isolation), they accepted their "neighbours" into the team. To develop positive attitudes toward their partners and achieve operational success, Group 2 subjects also needed the establishment of stable social and emotional relations. For the latter, more time was necessary than for the demonstration of an ability to work together. After both groups got used to spending free time together and several joint birthday celebrations, the subjects from Group 2 managed to establish the kind of close social contacts that they required.

Interpreting the criteria of Group 3, we theorise that what they mostly expected from their group members was for them to follow certain rules of social behavior and to provide emotional support. For them, these were the key factors for feeling psychologically comfortable and for perceiving others as similar and close. Cultural and language differences prevented national Russian and international groups from forming a common understanding of these behavioural rules and from establishing close emotional contacts. At the same time, Group 3 didn't match the operational expectations of Group 1.

According to R. Helmreich (7), effective adaptation to confinement and group cohesion correlates with the proper balance between task-orientation and socio-emotional orientation of subjects. From this point, we suppose that lack of balance between the primary orientation of Russian (where task-orientation dominated) and international (dominance of socio-emotional orientation) groups formed the background for the conflict between them. Deficits in mutual understanding, caused by the discrepancies in beliefs and values also negatively influenced conflict resolution process and resulted in closing of the hatch between the chambers.

We conclude that differences in perceiving one's interpersonal environment, group goals, beliefs, values and expectations hindered the formation of a joint cohesive crew for both national and international groups (9, 20). During psychological training of the heterogeneous ISS crews, special attention should be paid to establishing common understanding of group values and goals as a part of common crew culture.

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