Dysfunctional Behavior and Performance of Team Personnel in Space and Analog Polar Environments: Implications for Mars Missions

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Abstract

Reported are results from an ongoing project, which examines the key social structural variables thought to correspond with dysfunctional behavior and performance in extreme environments in a sample of space and polar groups. The study first operationalized what was meant by a deviant act in an extreme environment. Using this operationalization, multiple coders have been reading narratives, diaries, and logs from a number of space missions and polar field expeditions and are recording deviant acts. As occurrences of deviant acts and related data are extracted from mission and expedition records, descriptive statistics were employed to examine rates of deviance against crew size, heterogeneity, and mission duration in each mission and expedition. This methodology seeks to examine how crew size, heterogeneity, and mission duration structure deviance in extreme environments.

The specific hypotheses being tested are: 1) as crew size, heterogeneity, and mission duration increase, off-nominal acts increase; and 2) between the half-way point and the end of the third quarter of the mission, off-nominal acts increase in frequency (Third Quarter Phenomenon).

In collecting the data, additional data are being recorded to answer other questions in relation to the specific hypotheses: 1) Were there any differences between space and polar missions and expeditions; 2) were there any differences between Arctic and Antarctic expeditions; 3) were there any differences between earlier polar vs. later polar and space expeditions / missions; 4) were there any differences between shorter-term vs. longer-term missions and expeditions; 5) did odd-numbered crews have less deviance; and 6) did even-numbered crews have more deviance?

The project is producing an important space data base for long-duration missions, such as the Mars missions; important because past studies in this vein have been suggestive, qualitative, and where quantitative, lacked sufficient sample sizes and/or focused on data from well-prepared Antarctic bases or laboratory simulations which lack some important features as analogs of space missions.

An Overview

This study examines the key social structural variables thought to correspond with deviance in extreme environments in a sample of 75-110 space and polar field groups. It first operationalized what is meant by a deviant act in an extreme environment. Using this operationalization, multiple coders read narratives, diaries, and logs from 10 space and polar field expeditions and recorded deviant acts. Once occurrences of deviant acts and related data were extracted from mission and expeditions records, data was analyzed to examine rates of deviance against crew size, heterogeneity, and mission duration in each mission and expedition. This methodology sought to examine how crew size, heterogeneity, and mission duration structured deviance in extreme environments. The specific hypotheses tested were:

1) As crew size, heterogeneity, and mission duration increase, off-nominal, dysfunctional acts increase; and
2) Between the halfway point and the end of the third quarter of the mission, off-nominal, dysfunctional acts increase in frequency.

At first glance, it may seem that these are simplistic concerns. But, if these concerns were so simple, they would not loom so large in the literature and there would not be so many calls among high-ranking researchers for studies involving them.

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Do crews "go a little crazy" beginning halfway through an expedition or mission? Russian space psychologists must think so because cosmonauts Valentin Lebedev and Anatoly Berezevoy were told that they could expect a breakdown in relations about mid-way through the flight, but that later "everything will get to normal (Lebedev 1988)." The Third Quarter Phenomenon (or Syndrome) was characterized by J. H. Rohrer, who identified three stages of reaction to prolonged isolation, confinement, and stress. The first stage was a heightened anxiety brought about by the perceived dangers of the situation. The second stage occurs as the crew settles down to a daily routine, and is marked by depression and regrets about having joined the mission. The third stage is a period of anticipation, but features increased emotional outbursts, aggression, and rowdiness (Rohrer 1961). Earls called it a "half-way syndrome" which corresponded with a low point in the crew's morale beginning halfway through an expedition (Earls 1969). Evidence shows that these phases are present regardless of the length of the mission, whether it be days, weeks, or months. Sheddan thinks that with longer duration missions, the phenomenon is even more pronounced (1995). But, the fact is, the reality for Third Quarter Phenomenon has been anecdotal and, at best, suggestive in the literature of cold regions. Previous studies have been hobbled by not collecting or examining data for all four quarters of a mission. Robert B. Bechtel and Amy Berning (1991) have done the largest literature search to date and they say that Third Quarter Phenomenon seems to be a general characteristic of finite-time stressful situations. They argue, however, that "The question remains whether additional data can be found that either contradict or support this phenomenon." This study offers an analysis of a variety of situations that can confirm or call into question the existence of the phenomenon.

It is important to get answers to these research questions as soon as possible. Deviant acts would jeopardize the safe, productive human presence in space for extended periods, exacerbate the detrimental effects of space flight on humans, and make unproductive the use of space laboratories. Comprehending the occurrences and frequencies of these acts is essential to optimizing crew training and safety; making inferences about long-term individual and group performance responses to extreme environments; identifying critical factors and underlying mechanisms affecting those responses; assessing the psychosocial contributions to the optimal human habitability of space; designing equipment and systems; and providing insight into conflict between human capabilities and system engineering methodologies which can inform spacecraft design, mission planning, and related ground operations, and lead to development of new processes and procedures.

This study is consistent with Harrison's, Clearwater's, and McKay's call to attend to theory in regard to isolated and confined environments (ICEs) (1989), and has value in the prevention of dysfunction in these environments (Blair 1991) and in orienting those who find themselves living beyond this planet (Harris 1991). It is interested in incidents that are exemplified by the following passages from a space and a polar account.

November 1921, The Wrangel Island Expedition to the Arctic:
"The seamstress refused to patch a pair of boots to-day, so I tied her to the flagpole until she promised to repair them. Kindness failing to accelerate, I am trying something more forceful (p. 386)." Errol Lorne Knight in *The Adventure of Wrangel Island*. New York: The MacMillan Company, 1925.

September 1982, *Salyut 7*:
"We are tired of each other cramped in here in this small station (p. 300)." Valentin Lebedev in *Diary of a Cosmonaut: 211 Days in Space*. Texas: Phytoresource Research, Inc. Information Service, 1988.

As is well documented by now, NASA has had a history of neglect in regard to the human factors of space flight, especially the psychosocial human factors. The focus on short-duration flight had a hand in this. However, there is a slow turnabout in the making. The American space agency is not the monolithic organization the public perceives it to be. It is a decentralized organization composed of collegially competing field centers operating in a world of contractors (McCurdy 1993, pp. 129-138). Two different stances seem to be advancing from Johnson Space Center (JSC) (along with NASA-Ames) and the NASA Life Sciences Division at Headquarters in Washington, D.C. JSC and Ames lead the paradigm shift, noticeable in the literature beginning more than a decade ago. Researchers from both centers began to voice their concerns about the paucity of social and behavioral work in the space enterprise on the threshold of long-duration flight. Beginning in 1978, Mary M. Connors (NASA-Ames), Albert A. Harrison, and Faren R. Akins began updating the earliest discussions of human adaptation to life in space, identifying four important factors of future space flight: mission duration, crew size, heterogeneity, and mission objectives (1985, 1986). Yvonne Clearwater and Christopher P. McKay (both with NASA-Ames) and Albert A. Harrison encouraged behavioral research in space, polar, and similar settings (1989, 1991). Similarly, Robert L. Helmreich outlined the importance of applying psychology to missions that would steadily become longer, more heterogeneous, and host larger crews (1983). In spite of this movement, NASA psychiatrist Patricia Santy "discovered that all the work of [her] predecessors had disappeared into a black hole (1994, p. xvii)." She was only able to obtain the original Mercury, Gemini, and Apollo psychological data from a source outside of NASA. She also discovered that there was no documentation of psychiatric procedures for the Shuttle period (p. xvi). Bucking the old traditional system of neglect and disappearing documentation, brought her jibes of "being dangerous" and "trying to destroy NASA" (as late as 1988). Philip R. Harris reports that transcripts of crew communications going as far back as the Mercury flights likely have never been analyzed from a behavioral science perspective (p. 78).

If NASA scientists are split on the question of social and behavioral research, neither has deviance been a welcome subject of study within the NASA ranks. Because there is a paucity of social and behavioral scholars in the space agency, the term "deviance" itself is not understood beyond the way the man in the street comprehends the term. In spite of many space missions and many analogous expeditions of varying crew sizes and duration, no psychosocial human factors database as proposed here has ever been compiled, although it was certainly possible to have done so before now. This undone project may, in fact, be a deviant result of crews and sponsoring agencies wanting to appear "normal," which no doubt has fed into delaying the interest in extreme environmental psychosocial human factors by the space agency. In dealing with pilots and astronauts, the social and behavioral scientist soon realizes that in the eyes of the former and their administrators "no pilot or astronaut is deviant." Image is important, for no one wants to suggest that crew members do anything other than perform optimally. Even when crew members want to see improvements in living and working conditions they are hesitant to mention anything for fear that they may be viewed as complaining and that this will minimize their chances of staying on flight status. This is a classic disadvantage of an unrealistic reliance on models of military management and crew professionalism. According to Peter Suedfeld, it even goes beyond that. The "immensity of the scientific and technical problems of space flight, coupled with the technical background of many NASA personnel and the 'can do' attitude of the astronauts themselves, militates against giving much scope to psychology outside the boundaries of human factors engineering (Suedfeld 1991)."

People *are* capable of adapting to a variety of extreme isolated environments for long periods of time (Palinkas 1987). However, physical, psychological, social, and cultural research still must be conducted to further facilitate human adaptation to hostile, confined, and isolated conditions, because how people adjust and adapt to these conditions can affect not only their mental health and social cohesion but also their performance of assigned duties (Levesque 1991). Duties on a space station or on a Mars expedition will be much more complex than on short duration flights where many functions were or could be handled by ground controllers. The physical infrastructures of these ventures require built-in, on-board diagnostic capabilities wired into the spacecraft and equipment and not to the ground. This will require of the crew a level of maintenance, component replacement, redundancies, and techniques that have not been invented yet (McCurdy 1993, pp. 153-154).

Missions to polar regions are highly task-oriented in much the same ways that long-duration space missions will be, which is one reason why they are good analogs. There is one important difference to keep in mind, though. In space, there are minute-to-minute tasks or concerns involving life support. Damage to life support systems in the Arctic and Antarctic are not instantly life threatening. Depending on weather conditions and extent of damage, there is usually some amount of time to remedy a situation. Damage to life support systems in space is an immediate concern, i.e., breachment of environmental containment. Some degree of human dysfunction is tolerated and even expected in the Polar Regions, *but space may require of us behaviors closer to zero tolerance for deviance*.

More About the Significance of the Problem and the Methodology

Polar field expeditions make better space mission analogs than established polar base stayovers. A RAND report by Aroesty *et al*. have pointed out the costs of neglecting the whole range of human factors, including those areas having a bearing on deviant acts, and they also point out the difficulty with polar base stayovers as analogs (Aroesty 1991, pp. 88-89):

Crew selection, composition, compatibility, dynamics, and control structures need extensive research. Not only is little known about these issues in stressful, confined, long-term, and isolated environments, but aerospace community interest in this area has been limited. While recent acceptance of the importance of team training and team dynamics (crew resource management) is heartening; it is only a beginning. Excessive reliance on "crew professionalism" has been the hallmark in this area and open discussion of actual operating problems has been detrimental to the space program. Recent astronaut corp. acknowledgment of problems and their support of further research are major breakthroughs. . . . Meaningful analog studies are required, both on Earth and in space. While the Antarctic analog could be quite productive, *proposals that have the crews wintering over in prepared, established bases substantially miss the point.*

Similarly, Rivolier, Bachelard, and Cazes advocated putting crews bound for space research in the Antarctic, but away from the bases in order to enhance the resemblance to the work of being in space (1991, pp. 291-296). So difference is the space station from the well-prepared Antarctic base that Lebedev complained, "This is not the Antarctic, where everything is constantly changing (1988, p. 314)." Evidently, the cosmonaut thought that space station life was even more drudgery-filled or monotonous than Antarctic base duty.

As Patrick Cornelius has pointed out, since 1981, mid-winter airdrops of mail, fresh fruit and vegetables, movies, and home care packages have been made to those wintering over in Antarctic bases. This "erodes the completeness of the isolation somewhat (1991, p. 10)." While such re-supply trips resemble the occasional re-supply flights to space stations, this will be a rarity for bases on Mars, where current space policy calls for "living off the land." And, today's comfortable, well-prepared polar base cannot compare to the pioneering aspect of all current and near-future extraterrestrial settings. While the modern small polar stations *are* excellent operational analogs for human factor space research, as Bluth pointed out (1985), a space station, even though it is a base in much the same sense that Antarctic's McMurdo is a base, more resembles an Arctic field party with a semi-permanent encampment. One may expect to see behaviors resembling those of the latter in the newly pioneered extreme environments. And, in fact, Owens, while in Antarctica, was the first to see a disparity in the behaviors of permanent base crews and field base crews (1968). The permanent base offered relative safety, comfort, and low stimulation while the field parties were subjected to high hazards and high stimulus. Other factors may come into play to make the space mission highly comparable to the early polar expedition. With the cessation of "ground control" having so much to do with the functioning of the mission and with the decrease of constant communication with that control as space missions become more remote and/or more routine, crews will not have the opportunities to redirect aggression and resentment toward the "ground." Investigators may expect to see more of the intragroup hostility among small parties which have been observed in mountain climbing and polar parties (Suedfeld 1991, p. 141). Moreover, Blair points out an important difference between ICE environments now being pioneered and the well-established extreme environmental base (1991, p. 63): "All new contained environments lack the core of custom and tradition that stabilizes the Antarctic community from the first moments of its formation and provides that community with an expectation for success and techniques for coping with dysfunctional members."

Because of the focus on the modern Antarctic bases, most researchers have concentrated on contemporary records recording human activity at these sites, and only a few deem it of importance to include older records of exploration (which include field expeditions). A notable exception is Jack Stuster, who has paid attention to both the earlier and the modern records: year-long tours of duty at Antarctic stations and multi-year expeditions analogous to one- to three-year durations "contemplated for lunar outposts and a mission to Mars (1995, p. 3)." In doing so, he has been able to make recommendations to NASA about the design of spacecraft and habitats and about the operation of long-duration space missions.

Stuster examined the older polar exploration and seafaring records because of their comparability to longer space missions and their pioneering nature. This study examines them for the same reason. In addition, the older space missions have much to teach, providing data about mission duration, crew size, heterogeneity, and occurrences and frequencies of off-nominal, dysfunctional acts. An historic analysis of records from earliest times to present can show pervasive features that have stood the test of time so that mission planners and crews can avoid importing the deviant actions of the past into the future. Historical analysis also can capture changes in off-nominal aspects from earlier times till present. As Levesque has pointed out, much has changed even since the early social and behavioral research of the 60s and early 70s. Crew complement has gone from all military to military and civilian and from all male, to male and female. Polar communications has shifted from ham radio at best to satellite telephone calls. There have been many refinements in research theories and techniques (Levesque 1991). Moreover, in the Antarctic, there are increases in visitors and in the advent of families and increasing numbers of women. These changes will continue to require historical analyses of the data (Lugg 1991, p. 35).

Overall, this study is consistent with Harrison's, Clearwater's, and McKay's call to show methodological ingenuity (1989, 1991) and with Robert Helmreich's appeal to NASA (1983) to sponsor research using a variety of methodologies and research populations.

The Independent Variables: Crew Size, Mission Duration, and Heterogeneity

Crew size could not be determined simply by counting the number of participants in actual expeditions and missions. Problems associated with this were:

1) Members who drop out of the expedition close to the outset;
2) Members who join the expedition or mission while it is in progress; or who join for some duration, then leave after it has passed; or who may come and go at irregular intervals;
3) Members who die along the way or are evacuated for medical reasons.

Examples of these categories are demonstrated in this pilot study. During the Frozen Sea Expedition to the Antarctic, one of the men had to be flown out in the fourth quarter for behaviors that had become dangerous to the rest of the crew. During the International Geophysical Year traverse from Byrd Station to the Amundsen Sea, a Navy cook had to be brought out to the team so that it could concentrate on its scientific work better during the first quarter. During the *Salyut 7* 1982 orbital mission, two teams of three visiting cosmonauts each joined the two permanent crew members during the first and second quarters. During the *Apollo 11* mission to the moon, for the second and third quarters, Command Module Pilot Michael Collins was left alone in lunar orbit while Astronauts Neil Armstrong and Buzz Aldrin proceeded on to the moon in the Lunar Excursion Module. During the Wrangel Island Expedition, three of the crew were apparently lost through the ice on a traverse between the island and the Siberian mainland in the third quarter. During the fourth quarter of the same expedition, the surviving male back on the island died from scurvy or a kidney ailment, leaving one female sole survivor to be rescued. During the Lady Franklin Bay Expedition to the Eastern Arctic, 28 men set out, three left the expedition and 3 others joined it in the first quarter. In its fourth quarter, 25 men were whittled down to seven from starvation before rescue. Of the ten cases discussed in this report, only Will Steger's International Trans-Antarctic Expedition, the Western Party Field Trip of Scott's British Antarctic Expedition, the *Apollo 13* "lost moon" mission, and the Dominion Explorers' Expedition to the Arctic kept their full complement for the duration of those missions.

One way to handle the problem of crew size during any given quarter in a structurally meaningful way was to average the numbers of crew members from the minimum and maximum numbers of crew present during the quarter. This is what was done.

Mission duration was straightforward and was calculated by subtracting the ending date from the beginning date. The beginning of the expedition or mission was:

1) When the main body of the polar expedition sets sail or flies into the Arctic and Antarctic regions. These are invariably recorded in the literature as an official date of the beginning of the expedition.
2) When the space mission lifts off.

The end of the expedition is:

1) When the polar expedition is rescued; disbands to travel home; or returns as a unit home.
2) When the space mission returns to Earth.

Heterogeneity is a multi-dimensional variable consisting of variation in sex, nationality, age, and skill or experience. The variable of age was dealt with by calculating the range between the youngest and oldest members of the crew members in each quarter. This value represents the span of ages in the crew and has the advantage of being a single value for each quarter. Heterogeneity was calculated for sex, nationality, and experience using a standard sociological heterogeneity measure. Sex and nationality are uncomplicated concepts, but skill / experience requires some explanation. Skill / experience is understood as having had prior experience with engaging an extreme environment. That extreme environment does not necessarily have to be the same kind of environment as the one in which the expedition or the mission occurs; however, the prior environment in which the person became skilled in must have offered to him/her similar risks as the environment in which the expedition or mission took place. This understanding is derived from the selection experiences of the expeditions and missions studied. Sometimes organizers of polar expeditions selected crew members based on “several years of prior experience” only to find later in the field under extreme and primitive conditions during winter-over, that the real meaning of “prior experience” meant the person was flown in to make intermittent repairs at a well-outfitted Antarctic base for several summers. This would prove to be the same as having “no extreme environments skill.” The person who had worked as a field scientist on Alaskan glaciers year round would have had more similar skills than someone who had been on a polar field winter-over.

The Dependent Variable: The Deviant Act and The Pre-Test

What is a deviant act in an environment as extreme as space? A qualitative understanding of such acts defines them as acts that could jeopardize a part of the mission and/or the personal safety of one or more of those directly involved in the mission. A nominal conceptualization has been available from the cumulative expedition literature. It runs the gamut from a crew member’s show of frustration in communication with ground control, to his/her misusing a piece of equipment in a way which could be life-threatening, to delaying to report a critical piece of information, to expressed hostilities among crew, to display of mental disorders, to homicide. To go beyond description, though, required quantifiable data. A series of pre-tests given to extreme environments personnel arrived at a standard definition of the psychosocial off-nominal act in the extreme environment. That process has been reported on in detail previously by Dudley-Rowley (1997).

Among the respondents there was much overlap in labeling off-nominal those behaviors which involved neglect of tasks; survivability issues, including violation of safety rules; threats and coercion; mental disorder; threats to leader’s authority; assigning ownership to communal objects; poor base-crew communication; crew members mis-stating expertise and fitness; flaws in personnel selection; crew members pressuring each other for sexual gratification; poor hygiene; poor planning which resulted in neglect of critical tasks; base refusing to divulge important information for mission success; accidents with equipment owing to human error; physical and verbal abuse; and insensitivity of base personnel and expedition leaders.

The behaviors identified by the respondents were used to determine a unifying principle underlying deviance among expeditioners in extreme environments. This was in the form of three overlapping general categories of deviant behavior seen in the expeditionary record. These are:

1) Unusual, bizarre, or puzzling behaviors (such as withdrawal and life-threatening behaviors);
2) Acts of aggression (verbal and physical); and

3) Acts of deliberation (such as resources theft, hoarding or hogging resources, not doing one's work, and violating safety rules.) These examples here are meant to be representative, not exhaustive.

Coding Records

Size, heterogeneity, duration, and off-nominal behavior and performance data from space missions and space-like expeditions are being collected systematically from diaries, logs, and other narrative sources that are at about the same relative scale of reportage. For each mission or expedition, off-nominal acts are recorded as they occurred in chronological order.

For the purpose of a pilot study in advance of analyzing the set of 75-110 records, 10 missions and expeditions were examined. Missions and expeditions *have not* been selected based on their likelihood of containing deviant acts. All records have been selected randomly.

A decision not to select many records prior to the 1880s was based on the widespread practice before the convention of the International Polar Commission of misrepresenting expeditionary goals, discoveries, and conditions for nationalistic reasons. The assumption, the hope really, is that such practices are less widespread after that general time period.

From a practical standpoint, though, most records come from Arctic and Antarctic narratives, even though the investigator has access to space explorers. The reason is that not many astronaut and cosmonaut accounts are in the form of polar field expeditionary narratives, logbooks, and diaries, which are generally recorded on a daily basis. This poses a problem of scale in the analyses. However, there are exceptions, such as Lebedev's and Ryumin's diaries and the writings of Buzz Aldrin and Jim Lovell. For the expanded study, access to unpublished narrative records of astronauts and cosmonauts themselves are expected to expand this list. An alternate route dealing with this problem of scale would be access to space records that are not in narrative form, like Mission Control transcripts of missions, which are recorded on a second-by-second, minute-by-minute basis. The data could be coded separately according to the methodology prescribed here for the narrative records. Results from the two analyses could be loosely compared.

The investigator has attempted to keep numbers of Arctic records equal to numbers of Antarctic records. The space mission narratives included in this pilot study very nearly represent the entire population of that genre.

Results

There is a slight increase of mean rate of deviance per person per day in the third quarter over the ten cases, but it was not significant (Figure 1). However, it might be significant over 75 cases.

Did certain features of the data set contribute to high and low rates of deviance per person per day (Table 1)? The most striking finding to emerge is the difference between space missions and polar expeditions. The rates of deviance per person per day for all the space missions in this set occurred about the grand mean rate of deviance per person per day (.045). All of the polar expeditions' rates of deviance per person per day fell below .045.

The mean mission length in days was 293.8 days. The Lady Franklin Bay expedition (1080 days), the Wrangel Island expedition (720 days), and the Frozen Sea expedition (480 days) occurred above this mean. None of the missions' rates of deviance per person per day occurred above the grand mean rate of deviance per person per day. Only the *Salyut* space mission came close to having a correlation with a high rate of deviance per person per day at 212 days in length. The *Apollo 11* and *Apollo 13* space missions, the shortest of all the expeditions in this set, had the highest rates of deviance per person per day.

To explore the related issues of oddness and evenness of crew, a determination of which contained an odd number and which contained an even number was calculated from rounding up to the nearest whole number over the average crew complements. All even-numbered expeditions fell below the grand mean rate of deviance per person per day. Three of the five odd-numbered expeditions occurred above the grand mean rate of deviance per person per day. All three of the latter were the space missions.

Only two polar expeditions (Dominion Explorers and the Lady Franklin Bay expeditions to the Arctic) fell below the national heterogeneity mean of .433. All the other polar expeditions and the *Salyut* space mission were above that mean. Only the space mission had a high rate of deviance per person per day.

The Frozen Sea, Dominion Explorers', and the Wrangel Island expeditions all had a sex heterogeneity above the mean of .12275. None of these expeditions had a high rate of deviance per person per day.

Five of the polar expeditions occurred above the skill / experience heterogeneity mean of .154. None were above the mean rate of deviance per person per day. All of the space missions fell above the mean rate of deviance per person per day and were highly homogenous for experience. This flies in the face of conventional wisdom that advocates experience homogeneity.

Four of the polar expeditions occurred above the age heterogeneity mean of 17.75. None scored high for deviance per person per day. The most highly deviant missions per person per day, the space missions, were the most homogenous for age: the *Salyut* mission with an age range of 2 years, *Apollo 13* with an age range of 2 years, and *Apollo 11* completely homogenous for age.

An examination of the zero-order relationships between crew size, mission duration, and the various kinds of heterogeneity and rates of deviance demonstrated the following:

1. Expeditions of crew sizes over 3 persons fall below the grand mean rate of deviance per person per day (.045) (Figure 2).
2. Missions of 48 days and longer show a pattern of falling below the grand mean rate of deviance (.045) (Figure 3).
3. Expeditions where there is nationality heterogeneity of any amount show a pattern of falling below the grand mean rate of deviance (.045) (Figure 4).
4. Expeditions where there is age heterogeneity of 10 years and more show a pattern of falling below the grand mean rate of deviance (.045) (Figure 5).
5. Expeditions where sex heterogeneity was high showed a pattern of falling below the grand mean rate of deviance (.045); however, low rates of deviance could be observed in most of the sex homogenous crews, too. Two of the homogenous crews had rates of deviance above the grand mean (Figure 6).
6. Expeditions where experience heterogeneity was high showed a pattern of falling below the grand mean rate of deviance (.045); however, low rates of deviance could be observed in some of the experience homogenous crews. Two of the homogenous crews had rates of deviance above the grand mean (Figure 7).

The two crews ranked high for rate of deviance in relation to sex homogeneity and experience homogeneity were the *Apollo 13* and *Apollo 11* crews.

Latest tentative results also dramatically show that any category of homogeneity (sex, nationality, experience, and age) increases deviance over mission elapsed time. This is relatively consistent with the earlier information about Third Quarter Phenomenon which came from data sets of very homogenous crews; and with the latest studies over modern heterogeneous crews which tentatively do not seem to indicate the phenomenon.

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Table 1. Means for 10 Missions

Mission	Name	Duration	AvCrew	Sex Het.	NatHet.	AgeRan	SkillHet	DevAct	DaPrRt
1	Frozen Sea Expedition	480	5.875	0.445	0.6675	40	0.425	13.125	0.0175
2	*Salyut 7*	212	2.75	0.045	0.485	2	0	8.125	0.055
3	Wrangel Island	720	3.75	0.325	0.48	10	0.33	20.625	0.026
4	Lady Franklin Bay	1080	20.5	0	0.225	22.5	0.225	64	0.012
5	Int'l Trans-Antarctic Expedition	224	6	0	0.82	10	0	5.25	0.014
6	British Antarctic Expedition	48	4	0	0.63	11	0.38	0.5	0.01
7	Dominion Explorer's Expedition	72	16	0.4125	0.3975	60	0	2.25	0.006
8	International Geophysical Year Expedition	88	8.875	0	0.625	20	0.175	0.5	0.0025
9	*Apollo 11*	8	2.6667	0	0	0	0	0.5	0.1
10	*Apollo 13*	6	3	0	0	2	0	1	0.2225

Table 2. Data for 10 Polar Expeditions and Space Missions

Qtr. / Mis.	Dur.	AvCrew	SexHet	NatHet	AgeRng	ExpHet	Year	DevActs	DaPrRate	x1000
1 Frozen	120	6	0.44	0.66	40	0.44	82-83	23.5	0.03	30
2 Frozen	120	6	0.44	0.66	40	0.44	1983	11	0.02	20
3 Frozen	120	6	0.44	0.66	40	0.44	1983	10.5	0.01	10
4 Frozen	120	5.5	0.46	0.69	40	0.38	83-84	7.5	0.01	10
MisMean	**120**	**5.88**	**0.45**	**0.67**	**40**	**0.43**		**13.13**	**0.02**	**20**
1 *Salyut 7*	53	3.5	0	0.53	2	0	1982	10	0.05	50
2 *Salyut 7*	53	3.5	0.18	0.41	6	0	1982	8	0.04	40
3 *Salyut 7*	53	2	0	0.5	0	0	1982	9	0.08	80
4 *Salyut 7*	53	2	0	0.5	0	0	1982	5.5	0.05	50
MisMean	**53**	**2.75**	**0.05**	**0.49**	**2**	**0**		**8.13**	**0.06**	**60**
1 Wrangel	180	5	0.32	0.56	10	0.48	1921	58.5	0.07	70
2 Wrangel	180	5	0.32	0.56	10	0.48	1922	1	0	0
3 Wrangel	180	3.5	0.41	0.53	10	0.24	22-23	22	0.03	30
4 Wrangel	180	1.5	0.25	0.27	10	0.12	1923	1	0	0
MisMean	**180**	**3.75**	**0.33**	**0.48**	**10**	**0.33**		**20.63**	**0.03**	**30**
1 LFB	270	26.5	0	0.21	25	0.23	81-82	16.5	0	0
2 LFB	270	25	0	0.22	25	0.22	1882	22	0	0
3 LFB	270	25	0	0.22	25	0.22	1883	24.5	0	0
4 LFB	270	16	0	0.23	20	0.23	83-84	103.5	0.02	20
MisMean	**270**	**23.13**	**0**	**0.22**	**23.75**	**0.23**		**41.63**	**0.01**	**10**
1 Steger	56	6	0	0.82	10	0	1989	6.5	0.02	20
2 Steger	56	6	0	0.82	10	0	1989	8	0.02	20
3 Steger	56	6	0	0.82	10	0	89-90	2	0.01	10
4 Steger	56	6	0	0.82	10	0	1990	4.5	0.01	10
MisMean	**56**	**6**	**0**	**0.82**	**10**	**0**		**5.25**	**0.02**	**20**
1 Terra	12	4	0	0.63	11	0.38	1911	0	0	0
2 Terra	12	4	0	0.63	11	0.38	1911	0	0	0
3 Terra	12	4	0	0.63	11	0.38	1911	1	0.02	20
4 Terra	12	4	0	0.63	11	0.38	1911	1	0.02	20
MisMean	**12**	**4**	**0**	**0.63**	**11**	**0.38**		**0.5**	**0.01**	**10**
1 DomEx	18	9	0.16	0.23	60	0	1929	0.5	0	0
2 DomEx	18	15	0.42	0.46	60	0	1929	1	0	0
3 DomEx	18	19	0.53	0.46	60	0	1929	2.5	0.01	10
4 DomEx	18	21	0.54	0.44	60	0	1929	5	0.01	10
MisMean	**18**	**16**	**0.41**	**0.4**	**60**	**0**		**2.25**	**0.01**	**10**
1 IGY	22	8.5	0	0.64	20	0.1	1959	2	0.01	10
2 IGY	22	9	0	0.62	20	0.2	1959	0	0	0
3 IGY	22	9	0	0.62	20	0.2	59-60	0	0	0
4 IGY	22	9	0	0.62	20	0.2	1960	0	0	0
MisMean	**22**	**8.88**	**0**	**0.63**	**20**	**0.2**		**0.5**	**0**	**0**
1 *Apollo11*	2	3	0	0	0	0	1969	0	0	0
2 *Apollo11*	2	2.5	0	0	0	0	1969	1.5	0.3	300
3 *Apollo11*	2	2.5	0	0	0	0	1969	0	0	0
4 *Apollo11*	2	3	0	0	0	0	1969	0	0	0
MisMean	**2**	**2.75**	**0**	**0**	**0**	**0**		**0.38**	**0.08**	**80**
1 *Apollo13*	1.5	3	0	0	2	0	1970	0	0	0
2 *Apollo13*	1.5	3	0	0	2	0	1970	0.5	0.11	110
3 *Apollo13*	1.5	3	0	0	2	0	1970	3	0.67	670
4 *Apollo13*	1.5	3	0	0	2	0	1970	0.5	0.11	110
MisMean	**1.5**	**3**	**0**	**0**	**2**	**0**		**1**	**0.22**	**220**

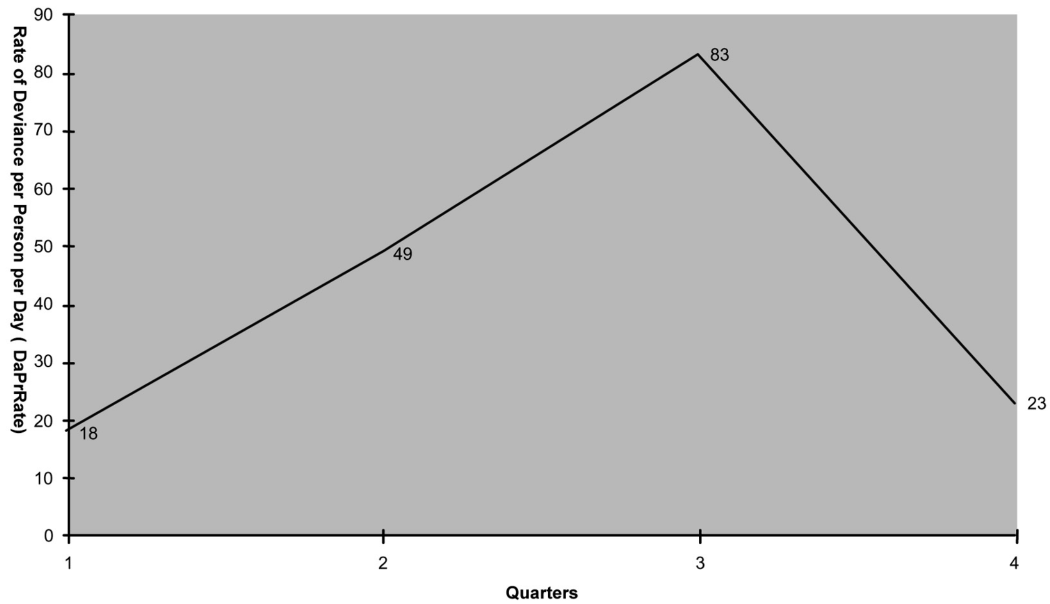


Figure 1. Rate of Deviance by Mission Quarter

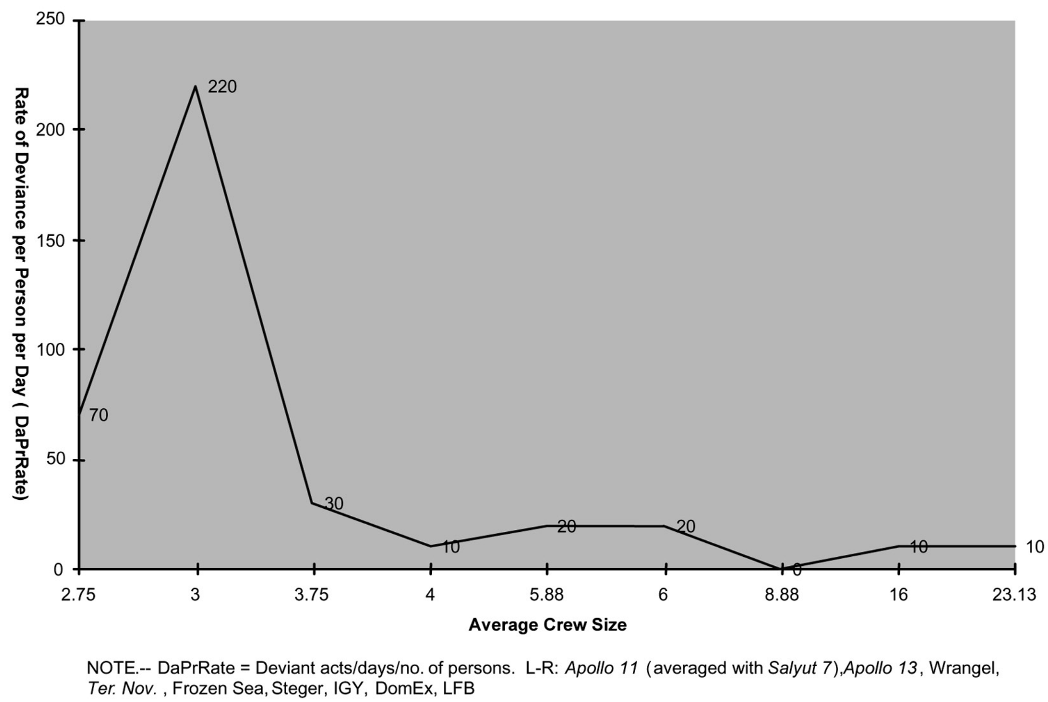
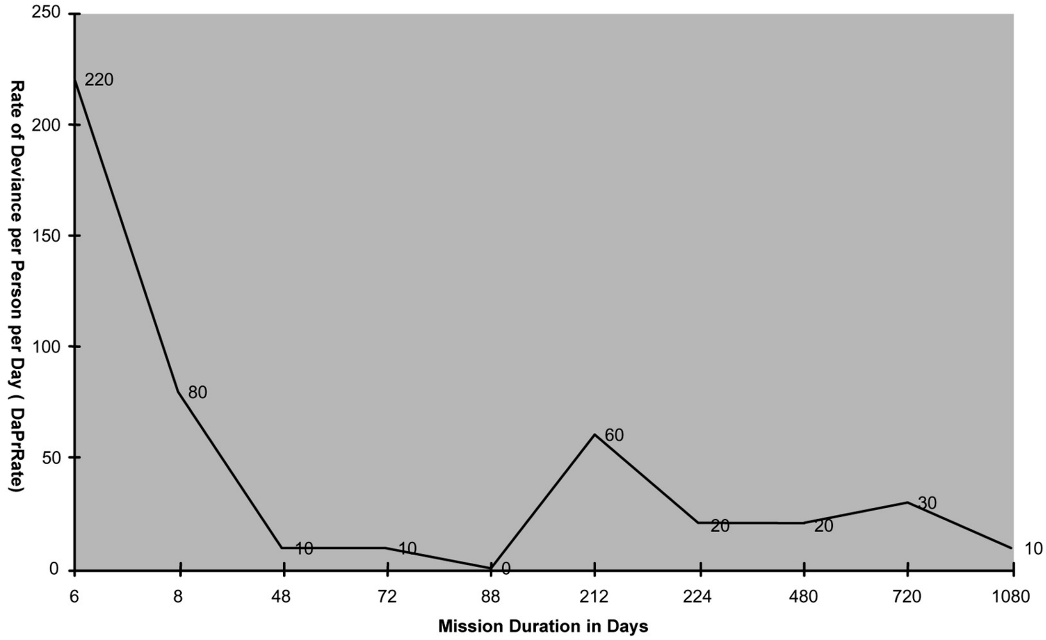
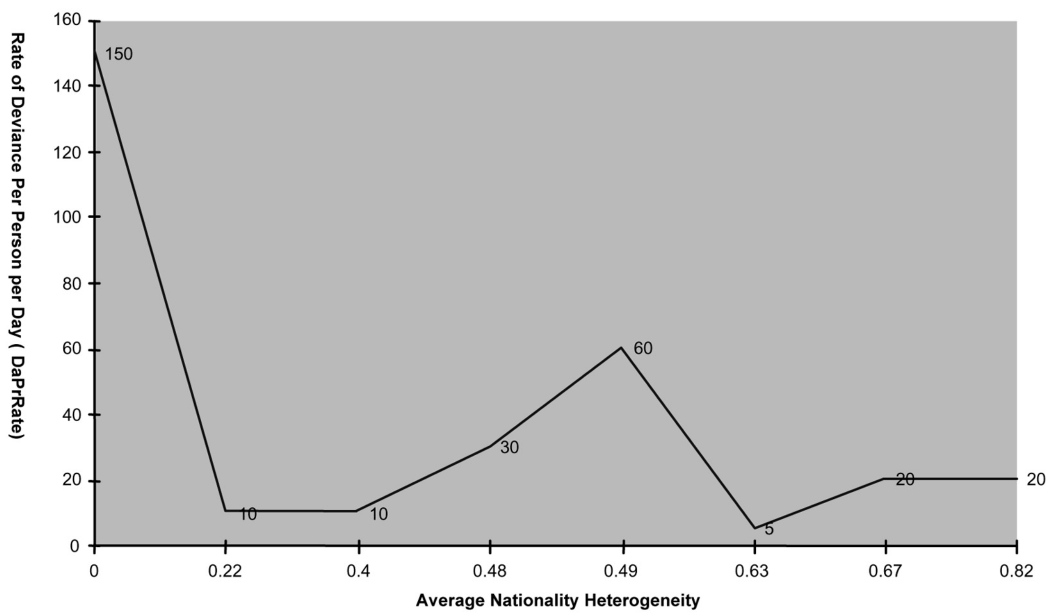


Figure 2. Rate of Deviance by Average Crew Size



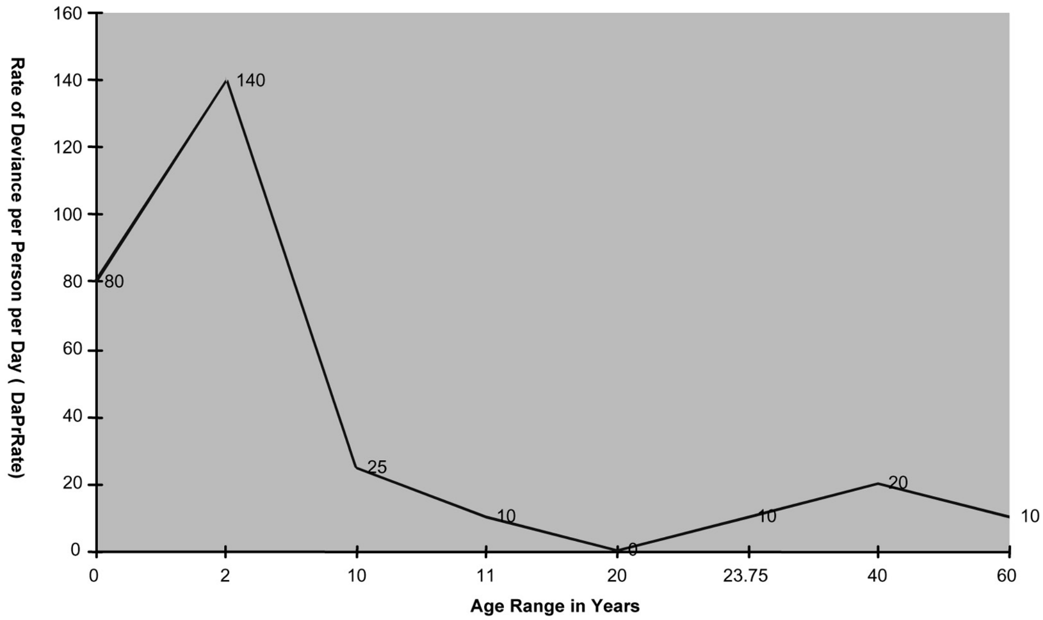
NOTE.-- DaPrRate = Deviant acts/days/no. of persons. L-R: LFB, Wrangel, Frozen Sea, *Salyut 7* , IGY, DomEx, Steger, *Ter. Nov.* , *Apollo 11, Apollo 13*

Figure 3. Rate of Deviance by Mission Duration



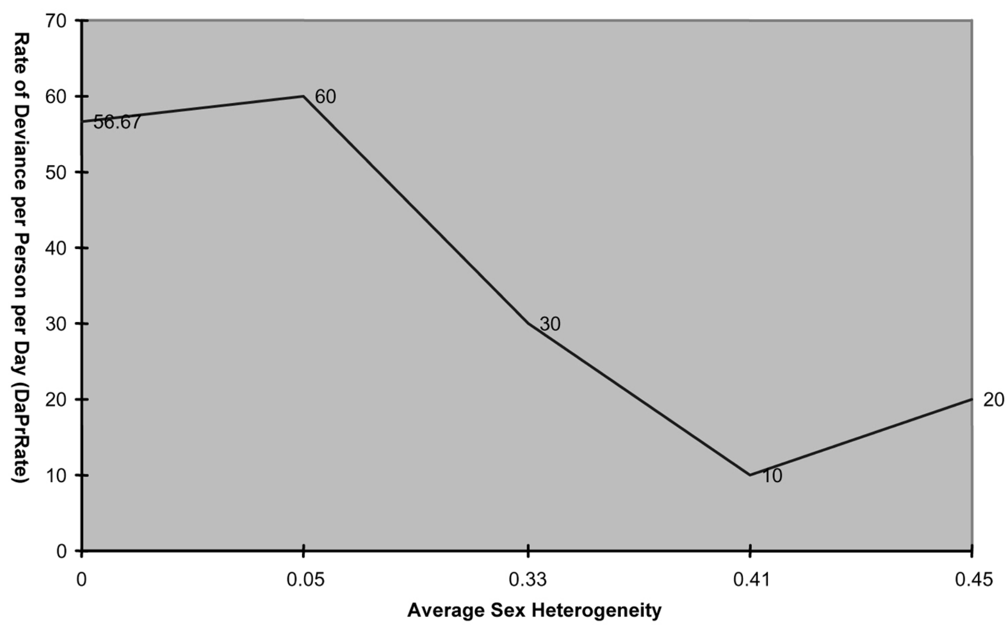
NOTE.-- DaPrRate = Deviant acts/days/no. of persons. L-R: *Apollo 13* (averaged with *Apollo 11*), LFB, DomEx, Wrangel, *Salyut 7* , IGY (averaged with *Ter. Nov.*), Frozen Sea, Steger

Figure 4. Rate of Deviance by Nationality Heterogeneity



NOTE-- DaPrRate = Deviant acts/days.no.pf persons. L-R: *Apollo 11*, *Salyut 7* (averaged with *Apollo 13*), Wrangel (averaged with Steger), *Ter. Nov.*, IGY, LFB, Frozen Sea, DomEx

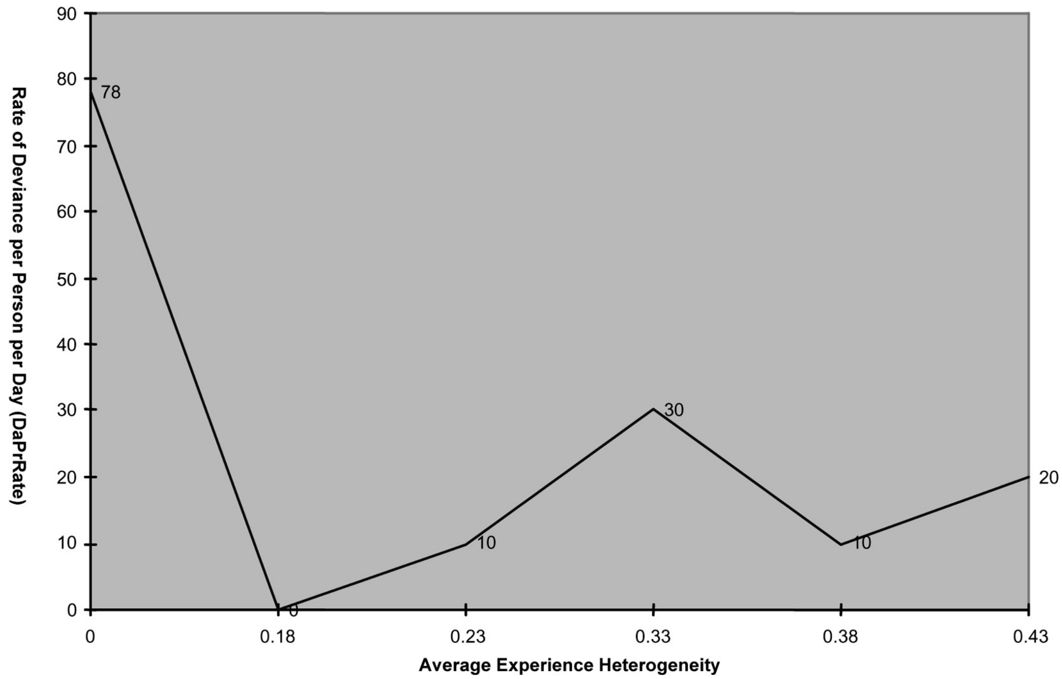
Figure 5. Rate of Deviance by Age Range



NOTE.-- DaPrRate = Deviant acts/days/no. of persons. L-R: LFB (averaged with Steger, *Ter. Nov., IGY, Apollo 11 and Apollo 13), Salyut 7, Wrangel, Domex, Frozen Sea.*

Figure 6. Rate of Deviance by Sex Heterogeneity

Figure 7. Rate of Deviance by Experience Heterogeneity



NOTE.-- DaPrRate = Deviant acts/days/no. of persons. L-R: Salyut 7 averaged with Steger, Domex, Apollo 11, Apollo 13), IGY, LFB, Wrangel, *Ter. Nov.* , Frozen Sea