UNIVERSAL VALUES, COPING STRATEGIES, AND MOTIVE IMAGES OF ASTRONAUTS AT THE INTERNATIONAL SPACE STATION

by

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ABSTRACT

Value hierarchies, coping patterns, and motivations of International Space Station (ISS) astronauts were examined in the present set of studies. Thematic content analysis was applied for references to above psychosocial markers in narratives (media interviews, journals, and oral histories) of 46 astronauts from the ISS expeditions. Results revealed that the five most mentioned universal values were identified as Achievement, Security, Benevolence, Universalism, and Self Direction. In regards to coping strategies, astronauts are more likely to use problem-oriented than emotion-oriented strategies. The top three coping strategies astronauts relied on were Seeking Social Support, Planful Problem Solving, and reference to Luck. In addition, astronauts were most likely to seek support in the form of personal information from their crew and ground control. Astronauts were most likely to be motivated by Achievement followed by Affiliation and Power. The role of leadership aboard the station was also examined. It was concluded that commanders were most likely assuming the supportive leadership role. The findings have important implications in understanding crew relations prior to and during the mission.

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INTRODUCTION

Long-duration space missions, such as those on the International Space Station, involve international crews of both genders who are responsible for completing complex assignments in isolated and extreme environments. These conditions allow for many physiological and psychological stressors to emerge. The stress experienced is not always negative; even living and working in harsh environments such as outer space can have positive effects (Suedfeld & Steel, 2000). With continuous advances in technology humans are able to explore untouched environments and are able to live in places not previously imaginable. Early space flights were very short and usually composed of heterogeneous flight crews hence psychological impact on performance and interpersonal relationships was minimal. Currently, the space missions are getting longer, with an average stay on ISS lasting between four to six months and in the foreseeable future a three year long voyage to Mars.

ISS is a low orbit research facility under the partnership of United States, Russia, Canada, Japan, and several European Countries. Tasks completed by astronauts on ISS include maintaining and building the station as well as participating in and running scientific experiments. Astronauts are selected to participate in four to six month Expeditions onboard the station. Each Expedition is composed of a crew of two or three astronauts. To date nineteen Expeditions have flown to the ISS. Expedition 20 will launch at the end of May 2009 and will mark the start of a six-person work crew.

As psychologists we can offer unique insight into understanding individual and social differences of astronauts. However, psychological research in the field is sparse.

The present study looks to fill the gap in our understanding of the psycho-social aspects of being an astronaut. The study investigates what motivates and drives astronauts' behaviour. As well it examines how they cope with the various stressors of space flight, and whether those strategies are healthy. We are also interested in what astronauts as individuals value and how or if their values are influenced by space flight. Finally, the study investigates the leadership role taken by the astronauts, more specifically, the crew commanders. In summary, three psycho-social variables: universal values, coping strategies, and motive images, were examined among the crew of eighteen ISS Expeditions.

The thesis progresses as follows. First, it outlines the physical and the social factors faced by astronauts in order for the reader to better understand the pressures encountered. Second, it will outline the additional pressures faced by the crew commanders. Three individual sections devoted to each of the psycho-social factors of interest will follow. Each section will describe the theory, results, and section specific discussions.

Physiological - Environmental Stressors

Muscle and bone mass atrophy

Exposure to microgravity prevents the normal function of bones and muscles in supporting body weight, resulting in a problem called disuse atrophy. Astronauts can lose up to 1% of their bone mass in a month as a result of disuse atrophy. Taking a combination of sex and growth hormones as well as exercising helps prevent disuse atrophy (Hullander & Berry, 2001).

Radiation

Radiation from the sun and galactic sources can increase the probability of astronauts getting cancer and other maladies. The space agencies are constantly working on developing better and stronger radiation shields.

Noise

The constant humming and background noise of life-support machinery can cause concentration and sleep disturbances (Suedfeld & Steel, 2000). Further, the constant monitoring of the noise for the failure of the machinery could create chronic tension.

Sleep

Astronauts on the ISS may see up to sixteen sunrises and sunsets in a 24 hour period. Research with shiftworkers has demonstrated that due to the abundance/lack of light/dark cycles individuals face desynchronization of their 24 hour circadian cycles potentially leading to major sleep disturbances (Scott, 1994). The sleep disturbances take a form of jet lag and shift lag with side-effects such as daytime fatigue, inability to sleep at night, irritability, and slowed physical reflexes (Toby, 1988 as cited in Stuster, 1996).

Safety

Astronauts live in one of the harshest external environments imaginable. The capsule they inhabit provides them with clean air and water, protection from the outside climate, and a way of escape. Nevertheless, the great possibility of equipment malfunctioning, fire, or collision with space debris could result in heightened awareness of one's personal safety (Stuster, 1996).

Confinement

Due to the lack of space, exercise may be limited. Not enough exercise can result in serious bone and muscle loss, sleepiness, decrease in mood, and compulsive behaviours (Suedfeld & Steel, 2000). Fortunately the space agencies have alleviated this problem by scheduling exercise and providing adequate equipment. One of the astronauts, Sunita Williams, ran an equivalent of the Boston Marathon during her ISS Expedition. In order to fight gravity, Sunita was strapped to the treadmill via shoulder and waist straps.

Astronauts are able to access the outside environment, however, the process takes years of training, is dangerous, and is focussed on a specific task. The spacewalks usually break the monotony, expose the astronaut to adventure, and beautiful scenery. View of the outside environment is also very important. Astronauts mention being entranced by the view (Haines, 1991) and stress the importance of large windows.

Duration

With increasing mission length, it is very important to monitor accumulating stress (Suedfeld, 1995 as cited in Suedfeld & Steel, 2000). Aspects only slightly annoying during a two week mission, such as fixing equipment and cleaning, may become very taxing and hard on a mission of six months. Several cases of drops in crew morale and performance after the midpoint of the mission have been documented (Kanas, 1998). On the other hand, increases in confidence and coping have also been reported with increased mission length in polar expeditions (Sandal, Vaernes, Bergan, Warncke, & Ursin, 1996).

Monotony

Monotony is defined as the “lack of sensory variation and novelty” (Berry, 1973). Due to the limited flow of communication or the unchanging sensory information inside and outside the station astronauts can get restless and agitated. In laboratory research, sensory monotony has lead to hallucinations (Sperber, 1969).

Social Stressors

Social monotony

Social monotony is the lack of social variation and novelty. It can result in boredom which then may lead to risky behaviour as a way to add some excitement and novelty. Visits by other crews who are on shorter missions can break the monotony and increase mood (Steel & Suedfeld, 1992). However, these visits may also cause conflict and confusion as the visitors are not aware of the unspoken customs and territory divisions.

Conflict

Slightly irritating habits of the crew, such as chewing loudly, may increase in annoyance as the mission progresses and lead to serious conflict among the crew. As well, group members can differ greatly in personality (Kubis, 1972), social skills, life experiences, education and expertise. Misunderstandings and individual differences could fuel long-term serious conflicts.

Scheduling

The balance between work and leisure time is very important. Astronauts’ schedules are usually filled with experiments, routine maintenance, and preparation for future jobs. Work schedules are dramatically altered in preparation for space walks or shuttle and supply ship

arrivals. There has been an organized protest from Sklylab 4 crew who demanded a reasonable work/leisure balance and more control over their schedule (Douglas, 1991). Over scheduling could lead the astronauts to start resenting their work resulting in poor performance and mistakes.

Sex

Most space agencies nowadays have active female astronauts. Including female members has resulted in no negative effects on group performance (Oliver, 1991). However, some females have reported feeling uncomfortable at mentions of sexual innuendo (Rothblum, Morris, & Weinstock, 1995). Recently much though has been given to all-female missions or those with already formed heterosexual couples (Leon & Sandal, 2003).

Heterogeneous crews

ISS crews are composed of astronauts of both genders and many nationalities. The cultural and religious differences could be the triggers for crew tension and low morale. The key factor to alleviating tension in heterogeneous crews could be the individual's capability to share the group's values and to build positive rapport and empathetic relationships with the crew (Kanas, 2009).

Leadership

It is essential for the commanders of the missions to adopt an efficient and respected leadership role. This is one of the major variables of interest in this report; therefore, the following section will be dedicated to exploring the research on leadership styles and outcomes in isolated and extreme environments.

In summary, the astronauts do experience some negative effects of space flight such as sleep disturbance, worrying about their safety, confinement, social monotony, and conflict among the crew. There are positive aspects of space flight and those have been reported to have a more lasting and greater effect (Suedfeld & Steel, 2000). For example, autobiographical accounts of early astronauts contain mentions of a great sense of adventure, fulfillment, and achievement (White, 1987).

Leadership in Space

Past research has investigated characteristics of good leaders in places considered analogous to space environments such as multi-crew aircraft cockpits, polar stations, and submarine environments (Biersner, & Hogan, 1984; Halpin, 1954; Helmreich, 2000; Leon, & Sandal, 2003; Nelson, 1964; Nicholas, & Penwell, 1995), in space station simulations (Kanas, Weiss, & Marmar, 1996; Sandal, 2001, Sandal, Vaernes, & Ursin, 1995) and most recently, in space itself (Kanas, & Ritsher, 2005; Kanas et al, 2000; Kanas et al., 2001; Kanas et al., 2006; Kanas et al., 2007; Kanas et al.,, 1996).

In analogue environments it was found that successful leaders were achievement oriented, confident, competent, optimistic and experienced. These leaders were seen to solicit advice from subordinates, delegate responsibility, participate in routine work and have a flexible leadership style. Leaders who managed to reduce clique rivalries and maintain group harmony were more successful (Nicholas and Powell, 1995).

To ensure optimal crew performance on long-duration missions the European Space Agency (ESA) organized three isolation studies in the 1990's (Sandal, 2001). The simulations involved small crews that were isolated for 28, 60, and 135 days. Up to 50 different experiments

were performed during the simulations including those that examined aspects of leadership (Kanas, Weiss, & Marmar, 1996; Sandal, 2001; Sandal, Vaernes, & Ursin, 1995). A study by Kanas et al, (1996) examined leadership style and group variables during the simulations. The study examined leadership style as composed of two roles: task or instrumental role and supportive or expressive role (Bass, 1981). The task oriented leaders focus on operational needs while support oriented leaders focus on the emotional needs of the crew. Answers to three subscales from the Group Environment Scale, leader control, leader support and group cohesion, were collected pre-, during, and post- simulation. It was found that leader control (measure of task orientation) decreased from beginning to end of mission and leader support (measure of supportive orientation) increased from pre-simulation to during simulation. Most importantly, both styles of leadership, as measured by leader control and leader support, were positively related to group cohesion throughout the entire mission. This implies that a good leader in a space simulated setting must be able to direct the crew in efficient completion of tasks but must also be sensitive to their emotional needs.

To date, the research team led by Dr. Nick Kanas is the only team to empirically examine leadership in space with the work conducted during the Shuttle/Mir program (Kanas & Ritsher, 2005; Kanas et al, 2000; Kanas et al, 2001) and most recently during the missions to ISS (Kanas et al, 2006; Kanas et al, 2007). The research aboard the ISS missions found a positive relationship between leader support (but not leader control) and cohesion. This was true for both Russian cosmonauts and American astronauts. The authors speculate that this finding may be due to a small and specialized crew, where each member is very knowledgeable in a particular field. Further, the missions are very structured by ground control, therefore the task role of the leader is not pronounced since each member has specific tasks they need to accomplish.

Following from the above research we predict that the commanders will take on the role of a supportive leader and focus on maintaining the emotional well-being of their crew. We can test the above prediction by examining how the commanders score on the other-oriented universal values, if their coping repertoire is large, and if they are motivated by both achievement and affiliation.

The above was a general overview of the factors astronauts encounter in their professional life. Bellow is the description of the method and the subjects used in the present study as well as results for the three psycho-social factors.

Method

The primary method of analysis was thematic content analysis (TCA). TCA involves objective and systematic conversion of qualitative data (such as diaries or interviews) into quantitative data allowing for standard statistical analysis (Carney, 1972). There are limitations to the method, for example, the quality of the data depends on the quality of the material. Also, the researchers are only able to score material in the languages they are fluent in. Importantly, the researcher cannot manipulate the environment, control the independent variables, ask specific questions, or make cause-effect inferences. However, if the limitations are properly addressed the advantages of TCA outweigh most negative consequences. First, a wide variety of materials can be scored, ranging from personal diaries to public speeches and autobiographies. Second, there are many variables available to be scored by TCA (see, e.g., Gottschalk, 1995; Smith, 1992), and if scoring criteria are not readily available for a variable of interest the researchers may create their own scale. Third, the method has high external validity. The participants are in no way influenced by the research questions, as the material is generated while the subject is engaging in everyday

activities. This results in an unobtrusive and naturalistic process of data collection (Carney, 1972; Holsti, 1969; Smith, 1992).

To limit the shortcomings of TCA, standard procedures regarding scorer training and inter-scorer reliability were taken. All scorers were required to attend a certification workshop for each of the independent variables. The workshop participants were required to complete background reading on the theory, attend an oral seminar for the specific variable, and score selected passages as instructed to by the scoring manuals. Trainees compared their scores to those of expert scorers and discussed their answers with the leader and other students. Following the conclusion of the workshop, trainees completed a test and were required to achieve a reliability level of $r = 0.85$ or higher with expert scorers on test passages.

To further ensure reliability, each archival source was scored by a main scorer and an independent reliability scorer. The main scorer was responsible for 100% of the material, while the reliability scorer was responsible for 20% to 60% of randomly selected passages. The two scorers needed to achieve an interrater reliability of $r = 0.85$ or higher in order to continue scoring. Any discrepancies were resolved through discussion between the scorers.

Subjects

The database consisted of archival materials produced by astronauts from the ISS. These included 2 NASA oral histories, 84 interviews from NASA and the media, and 18 astronaut diaries. All sources were retrieved online between September 2007 and January 2009.

Data Analysis

Data were analysed via the General Linear Model (Univariate ANOVA). In case of assumption violations, such as the homogeneity of variance, the Welch correction was applied (Cohen, Cohen, West, & Aiken, 2003). Repeated Measures ANOVA was used when differences between flight phases were analysed.

Independent Variables

Six independent variables were indentified from the literature (Table 1).

Table 1 Number of subjects by category.

Variable	*Category*	*N (total=46)*
Nationality	USA	23
	Russia	20
	Other	3
Gender	Male	42
	Female	4
Crew Size	Two	12
	Three	34
Job Title	Commander	17
	Flight Engineer	29
Status	Majority	16
	Minority	6
	Neither	24
Number of Flights	None	11
	One	16
	Two or more	19

As this is not an experimental study, we refer to independent variables as the categories into which we divided the astronaut sample based on the autobiographical and historical aspects of spaceflight. This enables us to analyse the data set with inferential statistics.

One of the independent variables was Mission Phase defined by whether the narrative refers to the time period before, during, or after the flight. Mission Phase was a repeated measures variable.

Home agency (NASA, RKA, and Other) refers to the space agency the astronaut is employed by. Specifically, “NASA” refers to astronauts, who were selected by and initially trained by NASA. These astronauts are not necessarily born in or are citizens of United States. RKA is the acronym for Russian Federal Space Agency, and refers to astronauts whose home agency is the Russian space program. ISS has many international partners such as those from Canada, Japan, and some European countries. “Other” refers to the astronauts from the international space agencies. The Other astronauts were excluded from analyses due to the small sample size (n = 3). Gender was excluded for the same reason.

Crew size (two or three) refers to the number of expedition members on ISS at one time; it does not include visiting astronauts or space tourists. This variable was included because it allows for the exploration of differences between groups in which subgroups could form and those in which they could not. Crews of three could form subgroups in which exclusion of a member could cause damage to overall group functioning. Presently the station is expanding to a crew of six and the current study could provide a foundation for future work regarding crew size.

Job position (Commander or Flight Engineer) refers to the job title and the authority of the astronaut throughout the mission. To distinguish the role of the commander, US Code of Federal Regulations (under Title 14 CFR 1214.702), states that a “commander shall be named to every

Space Shuttle flight so as to establish protocol and order where deemed necessary and to resolve such issues that might jeopardize both the mission and the cohesiveness of the crew" (US CFR, 2006). As mentioned earlier, individual differences between the crew commander and the crew are a key aspect of the study.

Heterogeneous crews face additional stressors than do homogeneous crews. They must learn to deal with different cultural backgrounds of the astronauts and the ground control. Status (Majority, Minority or Neither) refers to the astronauts' nationality status in reference to the other crew members. For example, in a crew of three, with two NASA astronauts and one RKA astronaut, the NASA astronauts are Majority members and the RKA astronaut is the Minority member. In a crew of two, with one NASA and one RKA astronaut, both are Neither a majority nor a minority member.

Flight Experience (zero, one, or two and more) captures the spaceflight experience of the astronaut. It refers to how many flights astronauts flew on prior to the ISS Expedition in question. In sum, there are six independent variables (Mission Phase, Crew Size, Job Position, Status, National Agency, and Flight Experience) of interest.

Dependent Variables

The three main dependent variables are universal values, coping strategies, and motives of astronauts on ISS. In general, coping is defined as a response to an environmental stress whose function is to return the organism to its equilibrium (Lazarus & Folkman, 1984; Suedfeld, Brcic, & Legkaia, 2009). Universal values are desirable, trans-situational goals, varying in importance, that guide behaviour (Schwartz, 1992). Motives drive, orient, and select behaviour (McClelland, 1961).

The remainder of the paper will be presented in sections divided by the dependent variables. Each section will consist of variable levels definitions and scoring criteria, followed by results and specific conclusions.

UNIVERSAL VALUES

Values are “desirable, trans-situational goals, varying in importance, that serve as guiding principles in people’s lives” (Schwartz, 1992). It has been proposed that the values represent conscious goals and must satisfy universal human motivations: biological needs, coordinated social interactions, and survival and welfare of one’s group. Even though values vary in importance as a result of age, gender, culture, and education, the values themselves and their motivational structure in relation to each other are consistent across all categories. Schwartz (1992) identified the relationship among the ten values postulated in terms of congruity and conflict among them. Achievement and Power are congruent values motivated by self-interest; they are in conflict with the values of Benevolence and Universalism which are motivated by self transcendence and welfare/interest of others. Values of Self-Direction, Stimulation, and Enjoyment are motivated by openness to change and new experiences as well as independent action. In conflict with the above four values are Conformity, Tradition, and Security, which are motivated by self restriction, order, and resistance to change.

People’s life circumstances enable or constrain them to pursue or express certain values. As a result, individuals adapt their values to the current life-circumstances. Individuals will raise the importance of values that can be easily attained in their environment and decrease the importance of values not readily attainable (Schwartz & Bardi, 1997). For example, individuals with jobs where constant improvement and achievement is encouraged will increase the importance of Achievement and downgrade the importance of Benevolence. However, the pattern mentioned is opposite for values of Power and Security (Inglehart, 1997). For example, those facing economic hardship will increase the importance of the value of Security in their life.

Adapting one's values to their life circumstances also holds a social benefit (Sagiv & Schwartz, 2000). When individuals in a given environment share the same set of values they are more likely to communicate with each other the importance of values, beliefs, and behaviours in that specific environment and group. By holding the normative values of the group individuals may benefit from increased social support and cooperation of group members.

As astronauts are working, living, and spending their free time together, cooperation among the crew is essential. In a laboratory study examining the consequences of cooperation and resistance to cooperation, the authors found that cooperative behaviour was positively related to values of Benevolence and Universalism and negatively correlated to values of Power, Achievement, and Enjoyment (Schwartz, 1996).

To date, only two published pilot studies have examined the values of astronauts (Suedfeld, 2006; Suedfeld & Weiszbeck, 2004). Suedfeld and Weiszbeck (2004) looked at the value hierarchy of four space flight veterans, "Buzz" Aldrin, Gordon Cooper, John Glenn, and Michael Collins. Due to the small sample only one conclusion can be made regarding all four astronauts; Achievement was the most frequently mentioned value. Suedfeld (2006) examined four values Achievement, Enjoyment, Benevolence, and Transcendence, in ten astronauts. For both male and female astronauts, Achievement and Enjoyment were the top two values. Male astronauts further placed importance on Benevolence followed by Transcendence, while the pattern for female astronauts was reversed.

Hypotheses

Based on the above two space-related studies we predict that the values of Achievement, Benevolence, and Enjoyment would be mentioned most frequently in our sample. We also predict

that values congruent to these will also be frequently mentioned. Those values would be Universalism (congruent with Benevolence) and Stimulation and Self-Direction (congruent with Enjoyment). The above values focus on openness to change and new experience as well as the interest in the welfare of others, all aspects one may associate with a successful astronaut. More specifically, we predict that commanders would score higher than flight engineers on Benevolence and Universalism due to their job of maintaining group cohesion and cooperation.

Scoring

A self-report value questionnaire, the Schwartz Values Survey (Schwartz, 1992), was adapted so that values could be analyzed via a TCA method. Rather than explicitly seeking answers to the questionnaire we identified in-text instances where values were mentioned. The new scale included an eleventh value, Spirituality. Previous published studies have made use of the adapted scale (Suedfeld, 2002; Suedfeld, 2006; Suedfeld & Weiszbeck, 2004) (Table 2). Seventy-two values (markers) were scored under eleven major value categories. For example, the major category Stimulation had four markers: Daring, Varied life, Boredom, Exciting life. Some of the original value markers were removed because they were irrelevant to present sample. New markers were added based on prior pilot research (Suedfeld, 2006; Suedfeld & Weiszbeck, 2004). Also, certain markers were reverse scored, such as Boredom (Stimulation) and Self-Doubt (Self-Direction). Examples from the narratives relating to each major value category can be found in Table 3.

Narratives were divided into paragraphs and each paragraph was scored for all eleven values. Each value was scored no more than once per paragraph, but more than one value could have been scored per paragraph. The inter-class correlation for each value category was $r = 0.80$.

All value markers were added per major value category to establish how often a specific value category was mentioned. We then divided the number of mentions per value by the total number of value mentions in that flight phase. This number was then multiplied by 100 to arrive at a percentage / frequency of the value being mentioned.

Table 2 Schwartz's major value categories and markers.

Value Category	Subcategory Examples
Power	Social status, prestige, control over people and resources
Achievement	Success through competence according to social standards
Enjoyment	Pleasure and sensuous gratification
Stimulation	Excitement, novelty, challenge
Self-Direction	Independent thought and action; choosing, creating, and exploring
Universalism	Understanding, appreciation, tolerance, protection of humans and nature
Benevolence	Welfare of people with whom one is in personal contact
Tradition	Respect, commitment, and acceptance of customs and ideas of one's culture or religion
Conformity	Restraint of actions, inclinations, and impulses that may upset or harm others or violate social norms
Security	Safety, harmony, and stability of society, relationships, and oneself
Spirituality	Meaning and inner harmony through transcendence, including (but not limited to) religious beliefs.

Table 3 Examples of Schwartz's values in astronaut narratives.

Scored as	Passage
Power	(Why in command) It was personally important to me. I made the request and it was saluted. I don't know what would have happened if they had said no.
Achievement	How many different types of vehicles have you ridden in during your lifetime? … I have added to my spacefaring total after yesterday! I have covered everything the United States Space Program has to offer. I even have time in all of NASA T-38 jets and assorted aircraft!
Enjoyment	My pastime is seeing how fast I can fly through the station. I can get some considerable speed up travelling between the two segments…but control is what I need to practice. Considerable style points are lost if stopping after a high speed run involves having my feet flip over my head!
Stimulation	The space walk was exciting, memorable, and a lot of work. Our days leading up to it were nicely paced with a long list of activities.
Self-Direction	When I was 2 or 3 years old I remembered watching people walk on the moon, and that was enough to inspire me so that for my entire life all I wanted to do was, was to become an astronaut.
Universalism	It's amazing what you can see when you just plain stop your hectic pace for an hour and open your eyes wide to watch the world go by. There are a lot of surprises and a lot of beautiful sights in this creation.
Benevolence	During the Expedition 9, four years ago, we were not lonely but there were only two of us. We didn't see any other human being for six months, and fortunately the commander and myself, we got along great.
Tradition	We talked about it and we decided that she's not going to come over. The Russian way of doing things is that you don't have your family come to launch, it's bad luck. You just say goodbye before you leave to go to the launch site. You go to the launch site and get you head into the game and go do it. We're following the Russian tradition that way.
Conformity	And my parents, especially they told me what to do. And I think the number one thing I would say to a young person in school right now is listen to those people.
Security	So it's a privilege and thanks again to the state of Texas that I'm allowed to exercise my privilege, my right, my duty to vote.
Spirituality	I saw a beautiful painting covering nearly an entire wall entitled 'Christ in the Wilderness.' … I thought of His 40 days in the wilderness, the difficulties of His life and the choices that were tearing at His heart. My journey didn't seem so hard anymore.

Results

The five most frequently mentioned values were Achievement, Security, Benevolence, Universalism, and Self Direction. Table 4 displays the complete value hierarchy. There were three significant changes from the pre-flight to the in-flight phase. Power increased from pre-flight phase M = 4.22% (0.73) to in-flight phase M= 16.55% (2.56) [F (1, 25) = 21.23, p < .001]. On the other hand, Achievement decreased from pre-flight phase M = 34.12% (3.50) to in-flight phase M = 16.55% (2.50) [F (1, 25) = 16.10, p < 0.001]. Lastly, Enjoyment increased from pre-flight phase M = 4.57% (0.89) to in-flight phase M = 11.14% (2.65) [F (1, 25) = 6.74, p = 0.02] .

Table 4 Hierarchy of Schwartz's values (%) across all flight phases.

Value	*Mean*	*SD*
Achievement	29.53	14.23
Security	10.04	8.26
Benevolence	9.66	7.34
Universalism	9.06	6.79
Self Direction	8.99	5.82
Stimulation	8.39	7.85
Conformity	7.84	6.87
Enjoyment	7.21	7.28
Power	6.26	4.98
Tradition	2.06	2.49
Spirituality	0.96	2.01

Pre-flight Difference

Table 5 displays all significant pre-flight differences.

Table 5 Intergroup differences for Schwartz's values (%), pre-flight.

Value	*Independent Variable*	*Mean*	*SD*	*df*	*F*	*p*
	Crew Size					
Conformity	Two	5.33	5.24	1,42	4.77	0.04
	Three	10.45	7.42			
	Status					
	Majority	13.99	7.31	2,42	8.93	0.001
	Minority	8.43	6.76			
	Neither	5.40	4.88			
	Position					
Power	Commander	5.05	3.77	1,42	6.84	0.01
	Flight Engineer	2.34	3.00			
	Position					
Universalism	Commander	9.92	8.38	1,42	3.59	0.06
	Flight Engineer	5.75	6.04			
	Position					
Benevolence	Commander	13.37	9.37	1,42	4.44	0.04
	Flight Engineer	8.00	7.31			
	Flight Experience					
	No Experience	5.68	6.92	2,42	3.23	0.05
	One Flight	13.81	9.68			
	Two or More	9.75	7.18			
	Position					
Spirituality	Commander	0.20	0.84	1,31	2.93	0.05
	Flight Engineer	1.46	2.95			
	Flight Experience					
Tradition	No Experience	0.24	0.80	2,23	3.04	0.01
	One Flight	2.83	3.49			
	Two or More	2.05	2.62			

Crew Size

Crews of three *M* = 10.45% (7.42), the larger crews, mentioned the value of Conformity more than did the smaller crews of two M = 5.33% (5.24) [*F* (1, 42) = 4.77, *p*=0.04].

Status

Majority crew members *M* = 13.99% (7.31) were more likely to value Conformity than were minority *M* = 8.43% (6.76) or neither *M* = 5.40% (4.80) crew members [*F* (2, 42) = 8.93, *p* < 0.001].

Position

There were four significant differences between the priority of values for commanders and flight engineers. First, commanders *M* = 5.05% (3.77) were more likely to mention Power than were flight engineers *M* = 2.34% (3.00) [*F* (1, 42) = 6.84, *p* = 0.01]. Second, commanders *M* = 9.92% (8.38) mentioned the value of Universalism more than flight engineers *M* = 5.75% (6.04) [*F* (1, 42) = 3.59, *p* = 0.06]. Benevolence was valued more by commanders *M* = 13.37% (9.37) than flight engineers *M* = 8.00% (7.31) [*F* (1, 42) = 4.44, *p* = 0.04]. Fourth, flight engineers *M* = 1.46% (2.95) valued Spirituality more than commanders *M* = 0.20 (0.84) [*F* (1, 31) = 2.93, *p* =0.05].

Flight Experience

Those with one prior flight *M* = 13.81% (9.68) valued Benevolence more than astronauts with no experience *M* = 5.68% (6.92) or more experienced space flight veterans *M* = 9.75% (7.18) [*F* (2, 42) = 3.23, *p* = 0.05]. Also, those with any experience, one M = 2.83% (3.49) or two and more flights M = 2.05% (2.62), valued Tradition more than space flight rookies M = 0.24% (0.80) [F (2, 23) = 3.04, p = 0.01].

In-Flight Differences

Table 6 displays the significant in-flight differences.

Table 6 Intergroup differences for Schwartz's values (%), in-flight.

Value	*Independent Variable*	*Mean*	*SD*	*df*	*F*	*p*
	Crew Size					
Self Direction	Two	15.28	14.49	1,10	7.37	0.05
	Three	4.03	6.83			
	National Agency					
Enjoyment	NASA	15.57	13.77	1,24	5.41	0.03
	RKA	3.13	8.84			
	Status					
Universalism	Majority	3.72	5.67	2.25	6.98	0.004
	Minority	24.85	10.89			
	Neither	10.50	10.90			
	Flight Experience					
Stimulation	No Experience	19.44	11.51	2,11	9.28	0.02
	One Flight	1.59	4.20			
	Two or More	4.45	7.85			

Crew Size

Smaller crews of two M = 15.28% (14.49) mentioned Self-Direction more than did the crews of three M = 4.03% (6.83) [F (1, 10) = 7.37, p = 0.05].

Status

Minority M = 24.85% (10.89) members placed a higher value on Universalism that did majority M = 3.72% (5.67) or neither M = 10.50% (10.90) status members [F (2, 25) = 6.98, $p <$ 0.05]

Flight Experience

Those with no experience M = 19.44% (11.51) mentioned Stimulation more than those with one prior flight M = 1.59% (4.20) or two or more prior flights M = 4.45% (7.85) [F (2, 11) = 9.28, p = 0.02].

National Agency

NASA astronauts M = 15.57% (13.77) were more likely to value Enjoyment then were RKA astronauts M = 3.13% (8.84) [F (1, 24) = 5.41, p = 0.03].

Discussion

Achievement was the most important value for astronauts. As predicted, Benevolence, Universalism, and Self Direction were also among the top five values. The one value that was not hypothesized was Security. Nevertheless, a deeper examination into the markers of Security may help us understand why Security is valued highly. In the present analysis, the markers of sense of belonging and being healthy were most likely to be mentioned by the astronauts. These are very relevant values to mention in an isolated and dangerous environment. It is not surprising that astronauts value Achievement greatly because they have reached personal success in their careers through competence and need continue being competent in order to continue advancing. Benevolence and Universalism are other-oriented values focussing on the welfare of others. Placing a high value on Benevolence shows that they are concerned with their in-group. By caring about the welfare of their crew the astronauts are ensuring positive and healthy social relations. In regards to Universalism, mentions of seeing the world as a blue and green marble without borders and the appreciation for humankind were frequent and would be scored as Universalism. In addition, since ISS crews are international, understanding other cultures and their customs is essential for crew harmony.

The changes in values from pre-flight to in-flight are interesting. The increase in Enjoyment is understandable due to the variety of new experiences that the astronauts face, for example, seeing the Earth, flying in zero gravity, creating new meals, and conducting interviews

with young and eager students while in orbit. The increase in the importance of Power may be a result of establishing one's own place within the crew and claiming limited resources. Lastly, the drop in Achievement could be a by-product of accomplishing the final goal of going to space after intense training; one could relax and focus on the tasks at hand.

As predicted, commanders did place a higher value on Benevolence, Universalism, and Power when compared to the Flight Engineers. Benevolence and Universalism show that the commanders care about the people they are in frequent contact with such as their crew, and that they care about the welfare of all people in general. These two values are also predictive of cooperation (Schwartz, 1996), an essential social tool in an isolated and extreme environment. They are also the markers we proposed would be present if the commanders were assuming the supportive leadership role. It is important to note that we do not know if the commanders originally valued the above two values at a high level or if they are adapting to their life circumstances of being a leader. A study examining the astronauts prior to position assignment or better yet, prior to becoming an astronaut would answer these questions.

Both astronauts from larger crews and majority members valued Conformity at a high level (10% or more). Those in larger crews restrained their impulses and refrained from breaking norms, supported by the findings that as group size increases so does conformity (Asch, 1951). During ISS Expeditions, the Majority members may be attempting to set and establish new group norms. They could be trying to demonstrate conformity to these newly formed standards.

Another interesting finding was that astronauts who had some flight experience valued Tradition more than astronauts with no flight experience. Those with flight experience respected and accepted customs and ideas which they were accustomed to or had experienced in their

previous flights. Those with no experience may not be aware of the customs and traditions onboard the ISS or they are coming in ready and willing to set new customs. The former explanation seems to fit best in this case.

A possible extension from the value hierarchy of ISS astronauts is to determine their most likely personality profile in respect to the Big Five Personality Traits. According to established correlates between the Big Five and universal values (Roccas, Sagiv, Schwartz, & Knafo , 2002) astronauts are most likely to be high in Extraversion and Openness to Experience as well as somewhere in the middle of the scale of Agreeableness and Conscientiousness.

We learned that overall astronauts focus greatly on Achievement, a very self-interested value. However, they are interested in the welfare of those close to them as well as the welfare of humankind. They are open to change and new experiences, and value safety and security in society and relationships. Their position and status within the crew creates demanding life circumstances that they adapt to and embrace. It seems that the adaption to those circumstances is in favour of crew welfare and harmony.

COPING

The following section will examine how astronauts cope with problems. In the socio-psychological framework coping is defined as a dynamic physiological and psychological process in response to perceived environmental stress (Lazarus & Folkman, 1984; Pearlin & Schooler, 1978). More specifically, it functions to restore physiological homeostasis and reduce negative affect (Lazarus & Folkman, 1984; Suedfeld et al., 2009).

Two distinctions in its function exist, emotion-focussed coping and problem-focussed coping (Lazarus & Folkman, 1984). Emotion-focused coping is more likely to occur if the individual perceives that nothing can be done regarding the stress. In this case, the individual may reframe the problem, selectively pay attention to certain aspects of the problem or deny the problem's existence. These are also referred to as person-oriented coping strategies (Endler & Parker, 1990). Problem-focussed coping or task-oriented coping emerges when the individual perceives that their actions can and will change the situation. Most of the problem-focussed strategies are oriented towards modifying the environment; however, some do focus on modifying one's own motivations and cognitions. Examples include creating detailed plans to solve a problem or seeking others to obtain help.

There seems to be stability within coping mechanisms, with some being more stable (i.e. positive reappraisal) than others (i.e. seeking social support) across situations (Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986). The success of a mechanism depends on the situation at hand; nevertheless, problem-focussed mechanisms tend to lead to more satisfactory outcomes than emotion-focussed ones. A standard set of coping mechanisms was used in this study to analyze the archival material (Folkman et al., 1986). Supernatural Protection was added

as an extra coping mechanism as it was used in previous studies in our laboratory with Holocaust survivors and astronauts (Suedfeld, Krell, Wiebe, & Steel, 1997; Suedfeld et al., 2009).

Middle-aged men and women, and college students have reported using both forms of coping in over 95% of stressful situations (Folkman & Lazarus, 1980). Research suggests that those with a more variable repertoire of coping behaviours have a better chance of resisting stressors and eliminating emotional distress (Perlin & Schooler, 1978). Individuals shift between the available mechanisms across situations and as situations themselves change.

Factors exist that aid and constrain which coping mechanisms are used. First, the coping style used depends on the available resources. Individuals with higher economic status and education employ mechanisms that lead to more favourable outcomes (Pearlin & Schooler, 1978). Second, social skills tend to facilitate problem solving with other individuals. Above average social skills allow for creation and maintenance of trust and cooperation with others (Lazarus & Folkman, 1984). Third, internalized cultural values and beliefs effect which coping mechanisms are used (Lazarus & Folkman, 1984). Cultural values can affect which situations are appraised as stressful and which mechanisms are used (Aldwin, 1994).

Research on coping strategies in isolated and extreme environments is scarce; however, some does exist. The most prominent finding is that planful problem solving (PPS) is the coping strategy used by members of teams venturing into extreme environments (Lester, 1980; Palinkas, 1986: Leon, McNelly, & Ben-Porath, 1989; Palinkas & Browner, 1995, Suedfeld et al., 2009). More specifically, Mt. Everest Expedition members and North Pole Expedition members are most likely to use PPS and Positive Reappraisal as coping strategies (Lester, 1980; Leon et al., 1989). We also predict that PPS and Positive Reappraisal will be among the top strategies used by the ISS astronauts.

While Leon, Kanfer, Hoffman, and Dupre (1991) also found the above listed pattern with coping strategies; in addition they found that Seeking Social Support (SSS), Self-Control, and Accepting Responsibility were prominently used by the international team crossing the Bering Strait. The least used coping strategies were Escape/Avoidance and Distancing. They also found a positive relationship between SSS and high stress reactivity as well as a negative relationship between SSS and well-being. They concluded that a high need for SSS may be a maladaptive personality characteristic in that particular situation. Palinkas and Browner (1995) found that members of the United States Antarctic program were most likely to use PPS and were also likely to seek for information, a subtype of SSS. Information seeking was related to depressive symptoms in Palinkas and Browner (1995). They suggest that coping may be more related to ongoing circumstances and the resources at hand than stable personality factors. For example, in expeditions studied by Leon et al. (1991) and Palinkas and Browner (1995) the crews were not able to contact family and friends often in order to seek support and information. Hence, by wanting to seek support from their families they were only making the situation more stressful due to the lack of resources to accomplish that goal. The present study will look in more detail at the types of support being sought by astronauts and who they seek the support from. We believe that SSS could be a healthy coping strategy if it is sought from the appropriate source and if the resources are available.

To date, there is only one published study that closely examines coping patterns of astronauts (Suedfeld et al., 2009). The authors found that SSS, PPS, Endurance / Effort, Positive Reappraisal, and Confrontation were the top five strategies mentioned by astronauts. Escape / Avoidance, Denial, and Distancing were the least used strategies. While the present study is very similar to the abovementioned, one key differences lie in the sample and the dependent measures

used. For example, Suedfeld et al. (2009) examined coping patterns of astronauts who flew long and short missions as well as those who flew prior to and after Apollo; the present study is only interested in long-duration international missions. Further, we are examining additional dependent measures such as job position and crew size. However, even with these differences we predict a similar overall pattern in the present study.

Hypotheses

We expect that PPS, Endurance / Effort, Positive Reappraisal, and SSS will be mentioned most often by ISS astronauts. More broadly, we predict that astronauts will use problem oriented coping more often than emotion oriented coping. Regarding the other dependent variables of interest, we predict that larger crews will be less likely to Accept Responsibility for problems at hand due to diffusion of responsibility (Darley & Latane, 1968). Astronauts with less experience may be more likely to use Supernatural Protection and/or Luck as a coping strategy. The selection process to get a flight, to manage all the training, and pass all pre-flight examinations may be perceived by first time fliers as uncontrollable. Therefore, they may attribute a part of their success to a mechanism which deals less with how they solve problems or emotionally alter stressors but to an outside source, such as luck. Finally, we predict that the commanders will use more coping strategies and at a higher rate than the flight engineers to help them maintain their emotional well-being and that of their crew.

Scoring

Thirteen coping strategies were scored as per established guidelines (Folkman et al., 1986) (Table 7). Initially, all of the material was divided into paragraphs and each paragraph was labelled for the appropriate flight phase (pre-flight, in-flight, post-flight). Coping was only scored when there was an external or internal demand that presented a problem and was identified by the

astronaut. Any number of coping strategies could be scored per problem. A reliability scorer scored 10%-60% of randomly chosen paragraphs. For the current variable, the interclass correlation was r = 0.85. Examples from the narratives used in this study can be found in Table 8. For each subject, the number of coping mentions was added per category and per flight phase. For each strategy, the total for the strategy was divided by the total of all strategies in a specific flight phase. The above score was then multiplied by 100 to arrive at the percentage of instances a strategy was used.

Table 7 Coping strategies and definitions.

Problem-Oriented		
1.	Planful Problem-Solving	Deliberate (rational, cognitively-oriented) effort to change or escape the situation
2.	Confrontation	Effort to resolve situation through assertive or aggressive interaction with another person
3.	Seeking Social Support	Effort to obtain sympathy, help, information, or emotional support from another person or persons
4.	Escape/Avoidance	Efforts to escape or avoid the problem physically
5.	Endurance/ /Effort	Trying to persevere, meet demands
Emotion-Oriented		
6.	Distancing	Effort to detach oneself emotionally from the situation
7.	Self-Control	Effort to regulate one's own feelings or actions
8.	Accepting Responsibility	Acknowledging that one has a role in the problem
9.	Positive Reappraisal	Effort to see a positive meaning in the situation
10.	Compartmentalization	Encapsulating the problem psychologically so as to isolate it from other aspects of life
11.	Denial	Ignoring or minimizing the seriousness of the problem, not believing in its reality
12.	Supernatural Protection	Invocation of religious or superstitious practices; efforts to gain such protection (e.g., prayer, amulets)
13.	Luck	Reliance on luck, chance

Table 8 Examples of coping strategies in astronaut narratives.

Scored as	*Passage*
Planful Problem Solving	I knew we would need to be efficient immediately upon insertion to orbit in order to get any photographs/video of the external tank, so I had mentally choreographed every step.
Confrontation	But I have also found that it is important to let the others know when something bothers you, because just like any other relationship…whether with a friend or spouse…if you let things go all the time, they will collect inside and always come out at the wrong time.
Seeking Social Support	Most days I can't even imagine how I will be touched by the amazing things that await me in outer space. I think of the challenges there and the mission goals we must accomplish, but I know one thing is certain, I can't accomplish anything without my family's support.
Escape/Avoidance	On the Sunday, a week after our arrival, the nurses mentioned that an "English TV crew" wanted to see us. We rushed down to reception, eager for any distraction, even an interview. It was ITN. They thought they were there to do a short interview, while we saw their presence as a way of escape.
Endurance/Obedience/Effort	I had a lot of challenges along the way but because I knew how to work hard and not give up, I was able to reach my goals.
Distancing	The good-bye could not be delayed and Donna finally brought it to the surface. I could hear her sniffing. She stopped and embraced me. "Mike, hold me." As I has always done in poignant moments in my life, I now tried to hide behind humour.
Self-Control	Throughout my short career as an astronaut I have been challenged physically, mentally and psychologically. Each time I had levels of anxiety that I knew I needed to overcome…exactly as I know I must on a long-duration space flight.
Accept Responsibility	And, especially in the first few hours and even days after landing, you have to be extremely "egoistic," so to speak. You have to be self-concerned, and follow all your body cues. I am just myself; I am one responsible. It is very important to listen to your body, and satisfy demands and needs.
Positive Reappraisal	I got my second choice, which was helicopters…I bring up all these little failures because it's one of those things that I tell kids that maybe you want something, but you get something else, but if you make the best of it, things sorta work out.
Compartmentalization	So it's been a tremendous volume of work, and, you know, we've tried to really compartmentalize but we've had a lot of time also. I think the other thing that we've prepared for, we spent more time thinking about how best to psychologically prepare not only for ourselves but for our families.
Denial	I find myself working longer and harder without even realizing it because it's exciting, it's getting close. But at the same time, 9½ years is a long time to wait. Maybe this is healthy, but a part of me still doesn't believe it's really happening.
Supernatural Protection	A simple key stroke for "deploy" on the computer, followed relatively quickly with an "abort" command, made difficult only by the fact that my fingers and toes were crossed, and I was saying a prayer, as well!
Luck	This taxi crew consisted of two Russian cosmonauts and one Belgian astronaut from the ESA. Luckily, I had met all of them prior to their arrival onboard the station, and I was comfortable in the knowledge that working with them would be easy.

The types of social support sought were also examined. After the scorers identified a coping strategy of SSS they further divided it into type of support, source of the support, and the action taken to get the support (Table 9). The scores were calculated in a similar fashion as for coping. The number of scores was added per category, per person, and per stage. The number for each category was divided by the total for the type, source, or action and then multiplied by 100. The resulting number is the percentage of time support was sought for of specific type, source, or action.

Table 9 Types of social support.

Types of Social Support	Sources of Social Support	Action
1. Looking for someone to talk to	1. Female Crew member	1. Seeking
2. Looking for expression of positive affect from another person	2. Male Crew member	2. Appreciating
3. Looking for reassurance, affirmation, encouragement of behaviour, action, work	3. Commander	
4. Looking for reassurance, affirmation, encouragement of beliefs, values, or expressed views	4. Parental Space Agency / Ground Control	
5. Seeking personal assistance in the form of knowledge, advice, expertise, and/or information	5. Foreign Space Agency / Ground Control	
6. Material assistance in the form of products, gifts, money	6. Non-crew member astronaut with experience	
7. Working together to solve problems	7. Spouse	
8. Sharing experiences	8. Parents	
	9. Children	
	10. Fans / people on the ground	
	11. Other social network	

Results

Overall Phase Stages

ISS astronauts used problem oriented coping strategies M = 64.28% (28.71) significantly more than emotion oriented coping strategies M = 33.06 % (29.40), [$t(42) = 3.59$, $p < .001$]. In

the overall hierarchy (Table 10), the top five strategies used were SSS, PPS, Luck, Positive Reappraisal, and Endurance/ Effort.

Table 10 Hierarchy of coping strategies (%) across all flight phases.

Coping Strategy	Mean(%)	Std. Dev.	Orientation
Seeking Social Support	26.60	21.61	Problem
Planful Problem-Solving	26.19	24.43	Problem
Luck	9.35	20.97	Emotion
Positive Reappraisal	9.03	14.06	Emotion
Endurance / Effort	8.59	12.27	Problem
Accept Responsibility	6.85	13.97	Emotion
Self Control	3.52	8.82	Emotion
Escape / Avoidance	2.40	8.18	Problem
Compartmentalization	1.45	7.68	Emotion
Denial	1.10	4.55	Emotion
Supernatural Protection	0.95	4.03	Emotion
Distancing	0.79	3.56	Emotion
Confrontation	0.50	1.81	Problem

Furthermore, Commanders used more coping strategies and at a greater frequency than Flight Engineers (8 over 4% vs. 5 over 4%) (Table 11).

Support Sought

ISS astronauts were most likely to seek personal assistance M = 53.46 % (39.35) and wanted to work together M = 19.89% (30.31), and were least likely to seek emotional assistance M = 0.46% (2.41). The source of support was usually one's crew M = 38.63% (38.43) and the ground control M = 36.34% (40.47). Astronauts were more likely to seek support M = 60.55% (43.64) than they were to appreciate it M = 39.45% (43.64). (Table 12). We found a relationship between action taken and the source of social support. There was a positive relationship between astronauts appreciating support from the source of family and friends [$r = 0.40$, $p < 0.05$] and a negative relationship between seeking support from the same source [$r = -0.40$, $p < 0.05$].

Table 11 Hierarchy of coping strategies (%) across all flight phases for commanders and flight engineers.

	Commander			*Flight Engineer*		
Coping Strategy	*Mean(%)*	*Std. Dev.*	*Rank*	*Mean(%)*	*Std. Dev.*	*Rank*
Seeking Social Support	21.62	23.61	1	29.87	20	2
Planful Problem-Solving	18.44	21.32	2	31.25	25.39	1
Luck	14.15	27.76	3	6.21	14.83	5
Accept Responsibility	11.47	16.99	4	3.83	10.92	6
Endurance / Effort	9.88	12.67	5	7.75	12.19	4
Positive Reappraisal	8.91	16.95	6	9.12	12.18	3
Self Control	5.56	9.41	7	2.19	8.32	8
Escape / Avoidance	4.79	12.41	8	0.83	2.73	11
Distancing	2	5.54	9	0	0	13
Confrontation	1.12	2.75	10	0.1	0.49	12
Supernatural Protection	0.79	2.24	11	1.06	4.91	10
Denial	0.38	1.58	12	1.58	5.71	9
Compartmentalization	0.09	0.36	13	2.35	9.84	7

Table 12 Type, source, and action (%) of social support sought.

Type	*Mean*	*SD*	*Source*	*Mean*	*SD*	*Action*	*Mean*	*SD*
Personal Assistance	53.46	39.35	Crew	38.63	38.43	Seeking	60.55	43.64
Working Together	19.89	30.31	Space Program	36.34	40.72	Appreciating	39.45	43.64
Behaviour-Action-Work	8.63	23.54	Family/Friends	12.67	24.56			
Talk	6.79	21.81	Other	12.36	28.81			
Sharing Experience	6.22	12.95						
Positive Affect	4.55	12.71						
Emotional Support	0.46	2.41						

Pre-flight Differences

Table 13 shows significant pre-flight differences.

Table 13 Intergroup differences for coping strategies (%), pre-flight.

Coping	*Independent Variable*	*Mean*	*SD*	*df*	*F*	*p*
	Crew Size					
Accept Responsibility	Two	15.58	19.10	1,13	8.28	0.05
	Three	2.92	9.76			
	Status					
	Majority	0.81	3.25	2,14	3.96	0.03
	Minority	3.00	4.69			
	Neither	12.55	18.13			
	National Agency					
Endurance / Obedience	NASA	17.93	19.03	1,35	6.85	0.01
	RKA	4.79	11.59			
	Status					
	Majority	7.28	12.25	2,18	1.48	0.06
	Minority	2.25	4.40			
	Neither	11.40	13.31			
	Position					
Planful Problem Solving	Commander	15.62	19.96	1,40	3.79	0.05
	Flight Engineer	30.29	26.51			
	Flight Experience					
Luck	No Experience	14.32	20.40	2,16	2.79	0.03
	One	15.83	29.30			
	Two or More	0.41	1.36			

Crew Size

In dealing with problems, crews of two M = 15.58% (19.10) were more likely to Accept Responsibility than crews of three M = 2.92% (9.76), [F (1, 13) = 8.28, p = 0.05].

National Agency

NASA astronauts M = 17.93% (19.03) were more likely to refer to Endurance / Effort than were RKA astronauts M = 4.79% (11.59), [F (1, 35) = 6.85, p = 0.01].

Status

Astronauts in crews where there were no majority or minority members *M* = 12.55% (18.13) were the most likely to Accept Responsibility when faced with a problem, as opposed to majority *M* = 0.81% (3.25) and minority *M* = 3.00% (4.69) astronauts [*F* (2, 14) = 3.96, *p* = 0.03]. Those same astronauts *M* = 11.40% (13.31) were also the most likely to use Endurance / Effort when compared to majority *M* = 7.28% (12.25) and minority *M* = 2.25% (4.40) astronauts [*F* (2, 18) = 1.48, *p* = 0.06].

Flight Experience

Those with no flight experience *M* = 14.32% (20.40) or only one prior flight *M* = 15.83% (29.30) were significantly more likely to use Luck as a coping mechanism than those with two or more flights *M*=0.41% (1.36), [*F* (2, 16) = 2.79, *p* = 0.03].

In-Flight Differences

Only one significant difference emerged in-flight. Flight Engineers *M* = 2.48% (4.61) were more likely to use Positive Reappraisal to deal with problems than were Commanders *M* = 15.25% (22.06), [*F* (1, 14) = 2.94, *p* = 0.05].

Discussion

Our prediction that problem oriented coping strategies will be used more than emotion oriented strategies was supported. In addition PPS, SSS, Endurance/Effort, and Positive Reappraisal were among the top five strategies used to cope with problems, as was predicted and as was found in previous literature. As discussed above, a varied repertoire of coping mechanisms allows one to have a better chance of resisting the stressors. In the current case we found that the commanders were more likely to use more coping strategies when compared to the flight engineers. Commanders have additional responsibilities such overall accountability regarding

crew safety and intergroup relations. It may be the case that the extra responsibilities are presenting varied situations in which a variety of coping mechanisms can be used. However, it is also possible that the commanders were chosen for their abilities to deal with stress more efficiently than the rest of the crew. In either case, by being able to cope in a variety of styles the commanders bring an additional sense of security to the mission, the ability to handle and teach others how to deal with most of the stressors in training and in flight.

Leon et al. (1991) and Palinkas and Browner (1995) found that using SSS was negatively correlated with well-being. In our study, ISS astronauts were most likely to use SSS as a coping mechanism. However, previous research (Leon et al., 1991; Palinkas & Browner, 1995) examined how astronauts felt after they tried to seek support from their family and friends, which was difficult at times due to their isolation. The present study examined a variety of sources and a variety of types of support to further disentangle the conflicting findings.

Interestingly, we found that when SSS was mentioned astronauts wanted personal assistance from their crew and the space agency and were not interested in emotional support nor did they want to 'just talk' about their problems. It seems that this type of SSS is attainable due to the proximity of the crew and the constant contact with ground control. Further, they are seeking support in the form of information or physical help, something the crew can readily help each other with. The support in form of positive affect and emotional assistance is not being sought often which in turn can reduce unnecessary conflict within the crew and the avoidance of uncomfortable situations. The astronauts appreciated the support they received from their families but were not likely to seek it from space. The astronauts are not attempting to seek support from distant sources, such as their families, and are avoiding additional stress that could result from the inability to communicate with family.

As was predicted, those in smaller crews were more likely to accept responsibility and acknowledge that they had a role in the problem. This may have resulted because in a crew of only two diffusion of responsibility was not possible. In larger crews of three and soon six, astronauts are able to avoid taking responsibility since there is always somebody else in the crew to blame. Tasks may be left undone or problems unresolved due to the lack of responsibility taken when problems occur. Astronauts in future expeditions should be trained and encouraged to quickly assume responsibility and deal with the problems immediately to avoid further complications and conflict.

Astronauts in crews where there were no majority or minority members were also more likely to accept responsibility for the problems they encounter. In this case the status variable and the crew size variable may be in conflict. All of the two person crews are also the crews with members who hold neither majority nor minority status. Further research with the crews of six will be able to disentangle the status and crew size variables.

NASA astronauts were more likely to use Endurance / Effort then RKA astronauts. In other words they were more likely to keep on trying to persevere and meet demands. One explanation for the difference may be that NASA astronauts are attempting to show their abilities and individuality by trying harder and working more than their crew members. Since they come from an individualistic culture they are trying harder to persevere and stand out.

Finally, as predicted astronauts with none or slight flight experience were more likely to rely on Luck to cope with problems than were those with two or more flights. The rookies in the space program were probably shocked by the reality of the flight after years of training that any problem resolution at that time may have seemed to occur by chance.

MOTIVE IMAGERY

Motives drive, orient, and select behaviour. Individual's motive dispositions are in the domain of personality concerned with goal-directed actions, the 'why' of behaviour (McClelland, 1987). In the present case we are interested in how often thoughts in written material spontaneously touched on the three motives: need for achievement (nAch), need for affiliation (nAff), and need for power (nPow). Need for achievement is defined as a concern for excellence and unique accomplishments and the need to compete and outdo others. Affiliation is described as establishing, maintaining, or restoring friendships encompassing affiliative and nurturant acts towards others. Power refers to impact, control, or influence over another entity (Winter, 1994).

Originally the motives were measured using the projective test called Thematic Apperception Test, TAT (Murray, 1938). The TAT was designed to reveal personality domains that were below the level of consciousness. Subjects were shown a set of pictures in which one or more persons were engaged in some behaviour. For example, one picture shows a ship captain and a younger man talking at a dock. None of the pictures directly implies the criterion motives. The subjects are asked to describe the scene on the picture, the characters themselves, what they are feeling, and how the scenario will be resolved. It is believed that their explanation will have personal relevance to how they relate to others in their life and how a similar situation may be resolved in everyday happenings. The above procedure was slightly modified by David McClelland by focussing on what the TAT approach can tell us about one's nAch (1958). The process was further adapted by David Winter to make it possible to score the three major motives from a variety of archival material, such as speeches, diaries, or audio/video media clips (1994).

At this time, it is important to distinguish between the values of Achievement and Power and the same motives. Motives are unconscious needs and wants. Individuals can not accurately

report the strength of their motives (McClelland, 1985). However, they can consciously express the values they hold and are able to evaluate their importance (Veroff & Smith, 1985). Motives drive the individual to be vigilant for cues relating to their goal and enable them to quickly learn goal relevant information. For example, individuals high in nAch perceive achievement oriented words more quickly (McClelland, 1985). Values do not serve the same function. Values "influence one's perception about other people and self-conscious choices" (Biernat, 1989). Biernat (1989) found that motives and values predict different behaviours. Motives predict real activity, such as math performance while values are useful in predicting self-report responses.

Among other findings, research on nAch has revealed a connection between nAch and task performance, personal responsibility, and occupational success. Early on, researchers found that individuals with a high nAch were more likely to prefer tasks of medium difficulty; they also performed better at the tasks of medium difficulty (French, 1955). Tasks that were too easy presented no challenge while those that were too hard had a low probability of success and were not attractive to those with a high nAch. The perfect task had to be intrinsically motivated and have a moderate probability of success. During such tasks, those who were high in nAch were more likely to take personal responsibility for task completion (Horowitz, 1961 as cited in McClelland, 1985). Also, it was found that those high in nAch were more likely to take calculated risks such as driving without a licence or overloading the car, but were less likely than those low in nAch to be in car accidents (Hoyos, 1965 as cited in McClelland, 1985). Regarding occupational success, those with high nAch were more likely to set their goals on occupations for which they were qualified for in terms of education and abilities (Mahone, 1960). They were also more likely to report higher satisfaction with work and did not see their work interfering with their family relations (Veroff, 1982). Based on the above findings and some anecdotal evidence we

predicted that astronauts would be high in nAch. For example, many astronauts mention that they receive adequate training for tasks they have to complete in space but that the novelty and the unpredictability of the environment keeps them active and wanting to learn more.

There seems to be strong relationships between nPow and aggressiveness, negative self-image, risk-taking, and occupational selection. Researchers have found that those with a high nPow when compared with those with low nPow were more likely to act aggressively (Veroff, 1982) and were more likely to feel inadequate (Veroff et al, 1980). Those planning to enter occupations such in teaching, journalism, or ministry were higher in need for power than those wanting to be doctors or lawyers. The latter group was said to influence through skill as opposed to personal power (Winter, 1973). We predict that astronauts would be low in their nPow. Through anecdotal evidence and careful astronaut selection we know that most astronauts are not aggressive, nor do they seem to have a negative self-image. Further, most are engineers or scientists and would be influencing others through skill. Finally, many of them say that the space agencies take many precautions to ensure their safety, and that the risk they take is calculated and hence not extremely dangerous.

However, it has been found that those in successful leadership positions display a specific 'leadership motive pattern'. These individuals are high in nPow, and low in nAff and nAch (McClelland & Boyatzis, 1982). Therefore, we predict that the commanders as opposed to flight engineers will display the leadership motive pattern.

Research focussed on nAff has revealed that those high in nAff were more likely to learn about social relationships quickly, engage in more dialogue with others, and maintain better connection with family and friends (McClelland, 1985). We expected the scores on Affiliation to

be fairly high but not as high as the scores for Achievement. We expected higher nAff scores in-flight because the astronauts would need to work on maintaining and in some cases establishing relationships with their crew and ground control; they would also need to maintain communication with their families on Earth.

Hypotheses

We predicted that overall astronauts would be greatly motivated by nAch followed by nAff and nPow. Further, commanders should display the leadership motive pattern when compared to the flight engineers. To clarify, overall the commanders will still exhibit the predicted pattern for all astronauts (high nAch, lower nAff and nPow) but when compared to flight engineers they will be higher in nPow, and lower in nAff and nAch.

Scoring

Winter (1994) developed a detailed method for scoring nAch, nAff, and nPow in written and oral information (Table 14). Specifically, each sentence is a unit for scoring motive imagery. A single sentence can be scored only once for a particular motive but it can be scored for two or more motives. However, if the same motive occurs twice in one sentence and is separated by a different motive than all three could be scored. If two consecutive sentences contain the same motive the motive cannot be scored in the second sentence; if the third consecutive sentence contains the motive then the motive can be scored in the first and third sentences. Motive imagery examples from the current project's narratives can be found in Table 15.

To calculate a motive score, we took the number of times a motive was mentioned and divided it by the number of words in the material. We then proceeded to multiply that score by 1000 to arrive at value that represents the 'number of motives per 1000 words'. Calculating ones

motive score in the above matter is believed to yield the highest correlation with behaviours that researchers are interested in predicting (Winter, 1994).

Table 14 Motive Images and definitions.

Motive	*Definition*	*Basic Forms*
Achievement	Scored for any indication of a standard of excellence.	1. Adjectives that positively evaluate performances (or the outcomes of implicit performances) such as "good," "better," or "best." 2. Goals or performances that are described in ways that suggest positive evaluation. 3. Mention of winning or competing with others 4. Failure, doing badly, or other lack of excellence 5. Unique accomplishment
Affiliation	Scored for any indication of establishing, maintaining, or restoring friendships or friendly relations among persons, groups, nations, etc.	1. Expression of positive, friendly or intimate feelings toward other persons, nations etc. 2. Sadness or other negative feelings about separation or disruption of a friendly relationship or wanting to restore it. 3. Affiliative, companionate activities. 4. Friendly nurturant acts.
Power	Scored for any indication that one person, group, institution, country, or other person-like entity has impact, control or influence on another person, group, institution, country, or the world at large.	1. Strong, forceful actions, which inherently have impact on other people or the world at large 2. Control or regulation. 3. Attempts to influence, persuade, convince, make or prove a point. 4. Giving help, advice, or support that is not explicitly solicited. 5. Impressing others or the world at large; mention of (or concern about) fame, prestige, reputation. 6. Any strong (positive or negative) emotional reaction in one person (group, nation, etc.) to the action of another person, etc.

Table 15 Examples of motive images scored in astronaut narratives.

Scored as	*Passage*
Achievement	Well by the time you get this, I hope I have made a good attempt at the 111th Boston Marathon
Affiliation	Later they were demonstrating hockey technique and Valery was being the goalie in the hatchway. To demonstrate that he was the goalie, he put his hand over his face, with his fingers separated so that he could see as Sergey shot the puck at him. I was having problems holding the camera still, I was laughing so hard. Since we had just watched the movie "Alien" together the previous weekend, I thought Valery looked a lot like one of the victims of an alien attack!
Power	But also I think this is important for ESA and for Europe to have two astronauts involved in the mission because this will be a high visibility mission in Europe.

Results

Across all flight stages the Achievement motive was mentioned most (M=2.73, SD=2.01) followed by the Affiliation motive (M=2.01, SD = 2.78) and finally the Power motive (M = .15, SD = .21). (Table 16).

Table 16 Hierarchy of motive images across all flight phases.

Motive	*Overall*	*Pre-Flight*	*In-Flight*	*Post-Flight*
Achievement	2.73 (2.01)	2.91 (2.04)	4.17 (4.9%)	4.07 (5.77)
Affiliation	2.01 (2.78)	1.95 (2.77)	3.46 (3.99)	1.51 (1.23)
Power	.15 (.21)	0.14 (0.21)	.07 (.15)	1.34 (3.06)
n	46	46	29	9

Commanders expressed a higher nPow than flight engineers, F (1, 45) = 6.12, p = 0.02. Additionally, commanders scored lower on nAch (M = 2.51, SD = 1.31 vs. M = 2.86, SD = 2.34) and nAff (M = 1.56, SD = .85 vs. M = 2.27, SD = 3.43) when compared to flight engineers. However the differences for nAch and nAff were not significant (Table 17).

Table 17 Hierarchy of motive images, by job position

Motive	*Commander*	*Flight Engineer*
Achievement	2.51 (1.31)	2.86 (2.34)
Affiliation	1.56 (.85)	2.27 (3.43)
Power	.25 (.24)	.10 (.17)

A significant pre-flight difference emerged between the National Agencies of the astronauts. NASA astronauts were more motivated by the nPow than were RKA astronauts, F (1, 41) = 3.96, p = 0.05.

Looking at changes across flight phases, Affiliation was the only motive that increased significantly from pre- to in-flight, F (1, 28) = 5.85, p = 0.02. None of the pre- to post-flight changes was significant most likely due to the small sample size for post-flight (n = 9). Nevertheless the increase in nAff and nPow are interesting (Figure 1).

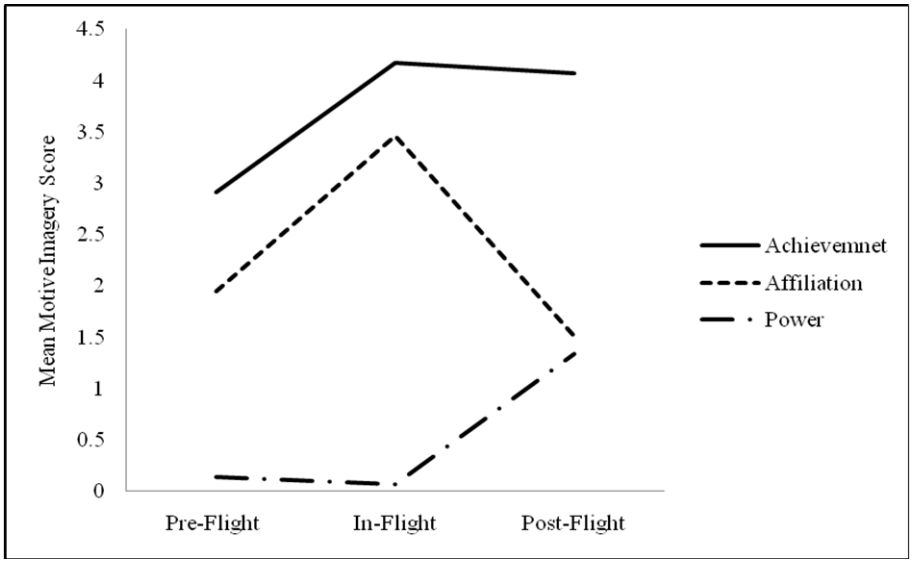

Figure 1. Changes in nAch, nAff, and nPow across the three Mission Phases.

Discussion

Most of the hypotheses were supported. The astronauts were mainly motivated by Achievement, followed by Affiliation and Power. Regarding differences between commanders and flight engineers, Commanders did exhibit a higher need for Power and showed a trend towards a lower need for Achievement and Affiliation.

It is important to discuss why the commanders were not motivated by nPow over the nAch, as has been found with successful managers and leaders (McClelland & Boyatzis, 1982). There is an environmental effect on the motives and their effectiveness in the specific environment. For example, Lawrence and Lorsch (1967) found that effective managerial integrators were high in nAff, reflecting their job demands of attaining employee cooperation and support. Therefore, due to the special environmental conditions of space-flight the commanders high in nAch may prove to be more efficient than those high in nPow. If the commanders were high in nPow more conflict among the crew could arise. For example, if they tried to help or give advice without it being solicited they could upset the crew.

The fact that NASA astronauts had a higher need for Power than those from RKA is not too surprising. USA and countries in Central and Western Europe are more individualistic than Eastern European countries such as Russia, which is a more collectivistic country (Ritsher, 2005). Therefore, NASA astronauts may have a greater tendency to voice their opinions and exert their individuality.

Finally, the pattern observed with an increase in the need for Affiliation in-flight and a drop in post-flight had been observed in previous research (Suedfeld, 2008). The increase in nAff could result from the need to maintain contact with family and friends while in space, or from

establishing and maintaining relationships with their crew. The increase in the need for Power post-flight is interesting. The astronauts may feel that they have gained valuable life and job experience while in space, and they expect to share and pass these experiences on to their peers and superiors, as well as the public.

OVERALL DISCUSSION

This was an exploratory study whose aim was to create a psycho-social profile of current international astronauts. In general, we found that astronauts are well-rounded individuals who care about the welfare of others but are strongly motivated by personal achievement.

Astronauts place high importance on a healthy mix of individually oriented and other oriented values. Achievement is motivated by self-interest while Stimulation and Self-Direction are motivated by openness to new experiences and change. A compliment to these is the importance of Benevolence and Universalism which are self-transcendence values motivated by the care for others. The balance between individual successes with concern for group welfare is important in a high stress social situation. It may demonstrate that while successfully completing tasks such as space walks or science experiments the astronauts know that it is equally important to address group needs and problems.

Problem-oriented coping strategies were more prevalent than were emotion-oriented ones. In accordance to research, this means that astronauts label more problems as controllable and are more likely to deal with their problems directly. Their coping patterns suggest that they are well adjusted and mentally healthy individuals. However, Luck and Positive Reappraisal are two emotion focuses coping strategies used often by astronauts. Luck was mostly used in the pre-flight stage and by those with limited flight experience. As mentioned earlier, in such a competitive and uncertain environment astronauts have an external locus of control due to lack of influence their actions and performances may have. Positive Reappraisal was high in-flight; not a bad strategy for astronauts to maintain a positive attitude and view problems lightly when other options may be limited in their restricted environment.

An important question was answered regarding the type of social support being sought and the source of that support. Contrary to past research, we found that the astronauts were seeking personal assistance in the form of information mostly from their crew mates and the space agencies. They appreciated the support from their families but did not seek it actively. These strategies are realistic because the crew is always present and the communication with agencies is frequent.

The third variable of interest was motive imagery. We demonstrated that astronauts are motivated by Achievement, followed by Affiliation and Power. Once again we saw the focus on personal success and establishment of positive, affiliative relationships.

A variable of great interest to the researcher was the leadership style used by the commanders. It was predicted that the commanders would assume the supportive role with the focus on the emotional well-being of their crew. Complimentary to research by Dr. Nick Kanas and his colleagues, we found markers that suggest that commanders did take on the supportive role. Commanders were more likely to value Benevolence and Universalism than did the flight engineers, a clear expression of honest care for their crew and humanity in general. Further, commanders used more coping strategies and at a greater frequency than the rest of the crew. This enabled them to solve problems in a variety of ways, a benefit when one's resources are limited. By being attuned to a variety of coping mechanisms commanders were able to help and encourage their crew to cope successfully. Finally, commanders were higher in Power motivation and somewhat lower in Achievement and Affiliation motivation than the crew as was predicted by the leadership motive profile. However, contrary to businesses managers the commanders were higher in Affiliation than Power motivation suggesting once again that they were assuming the supportive role.

Limitations

As mentioned previously, we were unable to directly ask the astronauts about their values, coping mechanisms or motives. We were only able to score what they spontaneously mentioned. Further, we were only able to score archival material we managed to locate publically. The public data could be presented in a rosy manner in order to maintain the integrity and a positive image of the space agencies.

Due to the young nature of the ISS, post-flight information was not available for many of the astronauts. Therefore, we could not tell how space flight influenced the participants in the long term; we were only able to make conclusions about the pre-flight to in-flight phases.

Any conclusions regarding the differences between commanders and flight engineers cannot tell us anything about their true, initial differences. Their assigned roles may be influencing all significant changes.

Finally, due to the small sample size of astronauts from agencies other than NASA and RKA as well as female astronauts no conclusions could be made regarding those two groups.

Future Directions

Most importantly we will continue to collect archival material for the current and future Expeditions as well as post-flight information. By maintaining our database we could answer some of the questions that we could not answer in the present project. For example, we would be able to examine changes between Canadian, Japanese, and European astronauts. We would also be able to study the permanent differences on their values, motives and coping strategies as a result of space flight.

We are currently in the process of analysing private journals. This we will help us examine the amount of influence the space agencies have over what is published publically. The biggest benefit of us analyzing the private journals would be to confirm and validate our method and to test the predictive power of publically available information.

Ultimately, a longitudinal study examining psycho-social aspects of astronaut candidates prior to selection to the return from their first space flight would help us answer many exciting questions. This may be possible with the current recruitment campaign of Canadian, American, and European astronauts.

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