



## **Perspectives on Asthenia in Astronauts and Cosmonauts: Review of the International Research Literature**

***Behavioral Health & Performance Research Element Space Medicine Division  
May, 2011***

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## **Acronyms**

BHP	Behavioral Health and Performance
BMed	Behavioral Medicine
CCMD	Chinese Classification of Mental Disorders
CGP	Cuban Glossary of Psychiatry
DSM	Diagnostic and Statistical Manual of Mental Disorders
ESA	European Space Agency
GLADP	Latin American Guide for Psychiatric Diagnosis
HRP	Human Research Program
ICD	International Statistical Classification of Disease
JAXA	Japan Aerospace Exploration Agency
POMS	Profile of Mood States
NASA	National Aeronautics and Space Administration
RFSA	Russian Federal Space Agency
SRP	Standing Review Panel

## Introduction

The Behavioral Health and Performance (BHP) Element is one of the six elements in the NASA Human Research Program (HRP) and is responsible for managing four of the identified and named risks to human health and performance from human space exploration: a) Risk of Behavioral Conditions (Behavioral Medicine [BMed]), b) Risk of Psychiatric Disorders (BMed), c) Risk of Performance Decrements due to inadequate Cooperation, Coordination, Communication and Psychological Adaptation within a Team (Team), and d) Risk of Performance Errors due to Sleep Loss, Circadian De-synchronization, Fatigue and Work Overload (Sleep).

Each risk is reviewed by a NASA HRP Standing Review Panel (SRP), and recently the Behavioral Medicine Risk of Psychiatric Disorders was reviewed. The aim of this report is to address one of the recommendations made by that panel, specifically the recommendation that the “literature on asthenia should be evaluated (possibly as a psychological or psychosomatic/psycho-physiological analogue of chronic fatigue syndrome)” (SRP p. 4), in addition to General Recommendation 4, which states that “all reviews must include non-English language materials as well as materials appearing in conferences reports, books, and other non-refereed journal outlets” (SRP p. 2).

This task was identified in the broader context of the following recommendations:

- The SRP recommends combining BMed2 and BMed3, and revising the gap as follows: What are the optimal methods to predict, detect, and assess adverse mood and other mental states (which may negatively affect performance) during and after exploration missions?
- The list of current tasks focuses exclusively on depression. There is no rationale for this limited perspective; there are many other negative states (i.e., irritability, fugue states, psychosomatic symptoms, anxiety) that occur in analog environments and have occurred in space flight.
- In the SRP’s judgment, it is unrealistic to expect the biomarkers for depression to be found in one research task; i.e., to be able to predict, diagnose, or measure depression using neuroimaging methods.
- An alternative approach would be to focus on the prediction of aversive conditions that involve affect, cognition, or behavior, based on findings in the literature on elite performers. This somewhat broader goal would refocus the effort on identifying affective, cognitive, and behavioral factors that are “early” warning signs of deterioration of performance. Moreover, these factors may not neatly fit into the categories that are described in the Diagnostic and Statistical Manual for Psychiatric Diagnoses. One of these factors is asthenia, which should be evaluated (possibly as a psychological or psychosomatic analogue of chronic fatigue syndrome), and another is General Recommendation 4.

This literature review on asthenia will be cognizant of the broader context above, particularly with reference to General Recommendation 4 (see above). According to the international literature (Aleksandrovskiy 1996, Carter et al. 2005, Carpenter 1997, Chaikin 1985, Gushin et al. 1998, Harris 1996, Holland & Curtis 1999, Kanas & Manzey 2003, Myasnikov & Zamaledinov 1996, Sipes & Vander Ark 2005) and anecdotal references (Burrough 1998, Flynn 2005, Freeman 2000, Harris 1996, Lebedev 1988), evidence exists that astronauts and cosmonauts have developed and suffered psychological

problems such as anxiety, depression, and asthenia during long-duration space flight missions, putting themselves and the mission at greater risk.

One disorder included in this evidence base of literature is asthenia, often described as experiencing weakness, with an increased tendency to have fatigue, irritability, and disorder of attention and memory. It has been seen by Russian medical personnel (flight surgeons and psychologists) in cosmonauts after 4 months in space (Grigoriev et al. 1996, Myasnikov & Zamaletdinov 1996). Russian medical personnel believe that asthenia is one of the greatest risks that will affect crews' optimal psychological functioning. Observing and determining whether astronauts and/or cosmonauts present asthenia symptoms or signs of asthenia during a space flight mission are crucial because asthenia can affect the crew members' health and performance, and mission goals.

Psychiatrists and psychologists around the world use many classification systems to diagnose psychiatric and psychological symptoms, signs, and diseases; however, countries can use their own unique diagnostic systems. For example, China uses the Chinese Classification of Mental Disorders (CCMD) and Cuba uses the Cuban Glossary of Psychiatry (CGP), which is a general framework taken from the Latin American culture. Another system used in Latin American countries is the Latin American Guide for Psychiatric Diagnosis (GLADP). On the other hand, the U.S. primarily uses the Diagnostic and Statistical Manual of Mental Disorders (DSM), and the World Health Organization and some European and Asian countries (including Germany, Switzerland, France, and Russia) use the International Statistical Classification of Disease (ICD). According to Shu (1998), "In general, different classification systems are almost all the same in common psychiatric diagnosis and therefore share a high consistency." However, the small differences between diagnostic systems have created debate about whether certain diagnosis classifications exist in certain countries. Additionally, it should be acknowledged that "in psychiatric practice, symptoms, recognition, disease construction, and taxonomic strategy are reflective and constrained by the cultural norms and values as well as the political and economic organizations of the society in which they are embedded" (Lee 1996).

Sadock and Sadock (2005) suggest that "when considering the different classification systems that exist and their cultural influences, there are many reasons why mental health professionals should care about the way in which mental disorders are defined. Firstly, the definition of mental disorders guides distinguishing pathology from what is normal. Consequently, the definition of mental disorders can influence estimates of the prevalence of psychiatric disorders in the community, which, in turn, influences the allocation of public health expenditures. Secondly, the definition of mental disorder can affect which behavioral, cognitive, and emotional perturbations are included in the classification, and the inclusion and exclusion of specific disorders from the DSM have been the source of criticism and controversy."

Asthenia (or neurasthenia) is one of those diagnoses that have created controversy around the world. The diagnosis of asthenia (or neurasthenia) is recognized by the World Health Organization in the ICD-10, but it is not recognized by the DSM-IV-TR (APA 2000). The DSM-IV-TR is the principal resource for NASA to diagnose psychiatric disorders (McPhee & Charles 2009, Slack et al. 2009). The fact that the DSM does not recognize asthenia as a diagnosable problem has caused international debate, especially in the area of space psychology. Russia and the United States. argue about whether cosmonauts and astronauts develop asthenia in space, and most importantly, they argue about whether we can prevent and treat asthenia during a long-duration mission. In addition, it is important to note that the DSM refers to neurasthenia as "a condition characterized by physical and mental fatigue, dizziness, headaches, other pains, concentration difficulties, sleep disturbance and memory loss" (APA 2000). It is described in an appendix called "Glossary of Cultural-Bound Syndromes," where it is listed as *shenjing shuairuo*,

referring in particular to the Chinese culture and not the U.S. culture (APA 2000, Hickie et al. 1997, Yew Schwartz 2002).<sup>1</sup>

From a multicultural perspective, there may be cause for concern that U.S. doctors' procedure for diagnosing disorders (that is, utilizing the DSM-IV) does not incorporate asthenia as a diagnosable psychiatric disorder. Indeed, "if our diagnostic systems do not readily match the symptom profiles presented, practitioners will continue to under-diagnose psychological disorders" (Kessler et al. 1994, Mason & Wilkinson 1996, Üstün & Sartorius 1995), which would have a strong impact on the international sharing of understanding and knowledge about astronauts' and cosmonauts' space flight experiences. It could also affect both appropriate training of the crew members and prescribed treatment based on observed symptoms. In addition, future missions will include multiple cultures, and this will necessitate evaluation of the mental status of an international space crew according to multiple diagnostic systems. As missions increase in duration and crews increase in diversity of national origin, these characteristics will likely create "cultural frictions in areas of leadership style, crew communication, pre-flight training, identification of in-flight mission success criteria, and post-flight differences in crew members' schedules" (Williams & Flynn 1999), which may increase the frequency and severity of symptoms related to asthenia.

In view of this situation, it was obvious that to determine the importance of continuing research on asthenia as a problem that might affect the optimal psychological functioning of crew members on long-duration space flight missions, it was necessary to do a systematic and comprehensive international literature review and conduct structured interviews with experts from around the world. The following is a summary of the review that was conducted, as well as a description of the interviews with researchers that were completed. The literature that was reviewed and researchers who participated in this project represented many countries including Canada, Germany, Spain, Japan, Czech Republic, Russia, New Zealand, and the United States. Important national and international literature in English, as well as non-English-language materials including journals, books, magazines, and conference reports, were reviewed.

This report was a collaborative international work effort focused on the evaluation and determination of the importance of continuing research on asthenia as a possible psychological problem that might affect the optimal psychological functioning of crew members during long-duration space flight missions. To that end, this report first describes the different definitions of asthenia that currently exist by examining the current literature on this topic; interviews that were conducted to represent the different multicultural perspectives of this issue are then summarized. Conclusions and recommendations specific to both the literature review that was completed and the interviews that were conducted are then discussed. In particular, the authors suggest that if this review conducted by the BHP Research Element finds enough evidence of asthenia in space, it is our duty to develop countermeasures to assess, predict, diagnose, monitor, and treat this condition in space, utilizing collaborative research projects both nationally and internationally.

## Defining Asthenia

The word *asthenia* (from Greek *a-*, without + *sthenos*, force), or "lack of energy," has been used for centuries worldwide to name concepts in areas like philosophy, medicine, and psychology (Berrios 2008, Boisser De Sauvages 1763, Brown 1804, Coutanceau 1821, Pinel 1812, Roche 1829, Silverman 1989). In the realm of psychology, the concept of asthenia has been adopted around the world and modified by cultural factors on the basis of subjective experience, making asthenia not only a difficult concept to define but also difficult to diagnose. Such subjectivity in the definition of asthenia has produced new

---

<sup>1</sup> It should be noted that all classification and diagnostic systems have limitations; accordingly, the DSM system recognizes its limitations and thus continues to evolve.

clinical disorders and descriptions such as neurasthenia (Arndt 1885, Verhaest & Pierloot 1981), psychasthenia (Berrios 1989, Haustgen 2004, Lantéri-Laura 1994, Oulahbib 2008), mental overexertion (Binet & Henri 1898), the so-called diseases of energy (Deschamps 1919, Deschamps & Vinchon 1932, Stiller 1907), aboulia (Berrios & Gili 1995), the fatigue syndromes (Berrios 1989, Bugard 1960), *shinkeisui-jaku* (Tsung 1989), *shenjing shuairuo* (APA 1994), neurocirculatory dystonia (Krapivnitskaya 2006), myasthenia (Drachman 2008), Gulf war syndrome (Hotopf et al. 2003), burnout syndrome (Freudenberg 1974), atypical depression (Angst 2002), and “a case of nerves” (Murray 1978). In addition, recent research has been instigated to explore new symptoms, syndromes, and diseases. Asthenia has also been considered synonymous with neurasthenia, major depression, chronic fatigue syndrome, and dysthymia, among other diseases. To illustrate the complexity of the topic of asthenia and its diversity in multiple cultures, Table 1 presents several definitions from around the world, including the medical, psychological, and psychiatric perspectives on this topic.

**Table 1. Definitions of Asthenia and Related Terms**

Term	Reference	Definition Quoted	Field	Country
Asthenia	Brown 1804	Asthenic diseases were caused by insufficient exciting power and had to be treated by strong stimulants, notably opium and alcohol; “sthenic” diseases were caused by an excess of the exciting power.	Physiology	U.S.
Asthenia	Tiganov 1975	Asthenia is a state characterized by heightened susceptibility to fatigue, fast onset of exhaustion, and partial or total loss of capacity for prolonged physical activity or mental exertion. Asthenia is a syndrome that should be viewed as an adaptive reaction due to exhaustion of the nervous system as a result of overexertion, lack of proper nutrition, disruptions in intracellular metabolism, and intoxication.	Space psychology	Russia
Asthenia	Aleksandrovskiy 1976	Three stages of asthenia are described:  Stage one: (Hyperesthesia) There is a general increase in sensitivity to external stimuli, resulting in hyper-arousal and increased (sometimes pointless) activity, emotional instability and irritability, impatience, decreased memory, poor attention and concentration, fatigue, headaches, perspiration, instability of pulse and blood pressure, and sleep disturbances.  Stage two: Irritable weakness, irritability, and emotional instability progress into more severe fatigue, negative emotional reactions, and somnolence.	Psychology-psychiatry	Russia

		Stage three: There is indifference and inertness, apathy, constant fatigue, passiveness, and lack of work capability.		
Asthenia	Encyclopedic Dictionary of Medicine Terms 1982	Asthenia is a state characterized by increased susceptibility to fatigue, frequent change of mood, irritable weakness, hyperesthesia, tearfulness, and autonomic nervous system and sleep disorders.	Physiology	Russia
Asthenia	Voloshina 1989	<p>The definition of asthenia is based on etiological criteria: psychogenic, physiogenic, somatogenic, and cerebrogenic asthenias result from the impact of extreme factors, causing maladaptation, especially when cosmonauts' roles are unequal.</p> <p>Psychogenic: Occurred when a psycho-traumatic factor was dominant. Is associated with apparent emotional instability, manifested in irritability or excitability with aggressive tendencies or extreme resentfulness and tearfulness.</p> <p>Physiogenic: Occurred as a result of gradual fatigue accumulation caused by overwhelming physical and mental strain. Decrease in performance and increase in asthenic phenomena presented and worsened after periods of hard work, and subsided after rest.</p> <p>Somatogenic: A correlation between asthenia and the phase as well as the intensity of a physical illness was observed, while asthenic symptoms had a tendency toward becoming more complex.</p> <p>Cerebrogenic: Occurred in subjects who in the past had experienced cranial trauma, arachnoiditis, and other central nervous system impairments that did not expressly manifest as organic symptoms, as well as subjects with cerebrovascular disorders of various intensity deemed of insufficient significance during pre-employment selection.</p> <p>Asthenia in these subjects was characterized by</p>	Physiology	Russia

		<p>acute irritability, sleep disturbances, and dysfunction of the autonomic nervous system.</p> <p>Three variants of asthenia:</p> <p>Non-pathological adaptational asthenic restrictions. Manifested as a decreased capability of psychological adaptation mechanisms to counter the impact of extreme conditions. The rate of function recovery in these cases largely depended on the degree of psychogenesis, fatigue level, physical predisposition, and severity of physical illness.</p> <p>Preexisting asthenic state: Encompassed pre-morbid form of adjustment disorders caused by adaptation mechanism breakdown and functional exhaustion of individual's psychological adaptation defense mechanisms. Increased polymorphism of symptoms.</p> <p>Asthenic disorder: Clinical forms of borderline neuropsychiatric disorders.</p>		
Asthenia	Aleksandrovskiy & Novikov 1996	Partial asthenia is a mild form of asthenia (hyposthenia) that develops in many cosmonauts after 1 or 2 months of flight. The hyposthenic state is one in which inhibitory processes predominate and is characterized by fatigue, decreased work capacity, sleep problems, anxiety, autonomic disturbance, attention and concentration difficulties, and heightened sensitivity to bright lights and loud noises.	Space psychology	Russia
Asthenia	Myasnikov & Zamaletdinov 1996	Asthenia is defined as "an abnormal state marked by weakness, increased tendency to fatigue, irritability, and disorders of attention and memory." Asthenia is distinct from normal fatigue.	Psychology-psychiatry	Russia
Asthenia	Gordeev et al. 2003	Asthenia is characterized by abnormal spontaneous fatigue and easy physical and mental fatigability that develops after minimal physical and mental work. It persists for a long time, and does not disappear after rest. It also includes emotional lability, increased anxiety, reduced motivation, sleep and memory	Physiology	Russia

		disorders, and impaired concentration. Asthenia violates physical and mental capacities and affects the patient's life and social activity. "Asthenia is often associated with psycho-autonomic syndrome (autonomic dystonia) and underlies the development of somatic and neurological disorders (Vein 1991). As differentiated from physiological fatigue, asthenia syndrome requires medical treatment."		
Asthenia or asthenization	Petrovsky & Yaroshevsky 1987 (p. 28)	"Nervous or mental weakness manifesting itself in tiredness... and quick loss of strength, low sensation threshold, extremely unstable moods, and sleep disturbance. [Asthenia] may be caused by somatic disease as well as excessive mental or physical strain, prolonged negative emotional experience, or conflict."	Psychology-psychiatry	Russia
Neurasthenia	Beard 1880	This author lists a set of 30 symptoms to diagnose neurasthenia, including dilation, abnormal activity, sick headache, pain pressure, heaviness in the back of the head, change in the expression of the eye, disturbance of the nerves of special sense, deficient mental control, mental irritability, hopelessness, morbid fear (the result of various functional diseases of the nervous system, implying a debility, weakness, incompetency, and inadequacy compared with the normal state of the individual), flushing and fidgetiness, insomnia, drowsiness, nervous exhaustion, feeling of profound exhaustion unaccompanied by positive pain, vague pains, and flying neuralgias.	Physiology	U.S.
Neurasthenia	Drachman 2008	Neurasthenia is the historic term for a myasthenia-like fatigue syndrome without an organic basis. These patients may present with subjective symptoms of weakness and fatigue, but muscle testing usually reveals the "jerky release" or "give-away weakness" characteristic of nonorganic disorders.	Physiology	U.S.
Neurasthenia	Morant et al. 1993	Asthenia is a pathological fatigue, also associated with various non-neoplastic diseases, particularly with acute or chronic infections. Symptoms include weakness, need to rest, lack of concentration, lack of appetite, problems with sleep, anxiety, and depression.	Physiology	Switzerland

Neurasthenia	WHO 2010 (ICD-10)	<p>Considerable cultural variations occur in the presentation of this disorder, and two main types occur, with substantial overlap:</p> <p>1) The main feature is a complaint of increased fatigue after mental effort, often associated with some decrease in occupational performance or coping efficiency in daily tasks. The mental fatigue is typically described as an unpleasant intrusion of distracting associations or recollections, difficulty in concentrating, and generally inefficient thinking.</p> <p>2) The emphasis is on feelings of bodily or physical weakness and exhaustion after only minimal effort, accompanied by a feeling of muscular aches and pains and inability to relax. In both types, a variety of other unpleasant physical feelings is common — feelings such as dizziness, tension headaches, and feelings of general instability. Worry about decreasing mental and bodily well-being, irritability, anhedonia, and varying minor degrees of both depression and anxiety are all common. Sleep is often disturbed in its initial and middle phases, but hypersomnia may also be prominent.</p>	Psychology-psychiatry	Worldwide
Neuropsychiatric asthenia	Encyclopedic Dictionary of Medicine Terms 1982	Neuropsychiatric asthenia is a decrease in functional capabilities of the central nervous system manifested in reduced performance, mental fatigue, worsening of attention and memory, and hyper-reactivity with irritable weakness, that occurs after serious illness or trauma or as a result of psycho-emotional overexertion.	Physiology	Russia
Psycho-asthenia	Encyclopedic Dictionary of Medicine Terms 1982	Psycho-asthenia is asthenia manifesting as increased susceptibility of psychological processes to exhaustion and delay in recovery, which occurs in combination with hyperesthesia and emotional lability.	Physiology	Russia
Psycho-asthenia	Alexandrovskiy & Novikov 1997	Psycho-asthenia often refers to problems in adapting to new external and internal factors (psychological maladaptation), meaning, essentially, asthenia that does not produce any psychotic disorders or major psychopathological disorders.	Space psychology	Russia

Psycho-asthenia / asthenia	Myasnikov & Stepanova 2000	<p>One distinguishing characteristic of asthenia syndrome is irritable weakness, which is expressed as elevated excitability, quickly changing (unstable) moods, and irascibility. All these expressions intensify in the afternoon or closer to the evening. The mood is usually low with some traces of petulance and dissatisfaction. Asthenia syndrome is frequently accompanied by headaches and sleep disturbances that present as increased sleepiness or persistent insomnia, as well as low tolerance for bright light, loud noises, and sharp aromas.</p> <p>Asthenia syndrome in space can be identified in three different stages:</p> <p>First stage: Expressed primarily as a heightened emotional excitability.</p> <p>Second stage: Characterized by a set of symptoms, at the heart of which are mood swings, frequent fatigue, decrease in performance quality, and signs of sleep disturbance.</p> <p>Third stage: Consistently low mood, expressed irritability, conflict tension, hypochondriac phenomena, frequent and significant errors in performing work-related tasks, and expressly manifested sleep disturbances (requiring systematic use of sleep aid medication).</p>	Space psychology	Russia
shenjing shuairuo	APA 2000 (DSM-IV-TR)	A condition characterized by physical and mental fatigue, dizziness, headaches, other pains, concentration difficulties, sleep disturbance, and memory loss.	Psychology-psychiatry	Japan
shinkeisui-jaku	Tsung 1989	A psychological reaction developed in a certain type of personality characterized by hypersensitivity, introversion, self-consciousness, perfectionism, and hypochondriacal disposition.	Psychology-psychiatry	China

The first and most important conclusion from this table is that *asthenia or neurasthenia* does exist as a psychopathology despite the lack of recognition of it as such by some countries (including the United States and Canada). The authors also found that asthenia has considerable cultural variations; therefore,

the diagnosis and treatment vary significantly depending on the physician's medical specialty and country. For example, from the Russian space psychology perspective, "psychoasthenia" does not produce any psychotic disorders or major psychopathological disorders (Alexandrovskiy & Novikov 1997). On the other hand, Russian physiologist Gordeev (2003) states that asthenia does not disappear after rests and requires medical treatment. In Japan, neurasthenia (*shinkeisui-jaku*) is treated with rest, nutrition, improved hygiene, adjustment of work and lifestyle, and psychotropic medication (Yew Schwartz 2002). In China, neurasthenia has been reported to be the second most important diagnosis in psychiatric hospitals (Lin 1992, Ware & Kleinman 1992). In far Eastern countries, neurasthenia is considered a curable physical condition with a biologic explanation and without the stigma of a psychiatric diagnosis (Flaskerud 2007). In a study conducted in Australia, Hickie and colleagues (2002) concluded that neurasthenia is typically chronic and is associated with high levels of co-morbid affective and anxiety disorders.

Despite the demonstration by epidemiological studies that neurasthenia is a common psychopathology in many countries, questions remain for NASA, including: a) Does asthenia, neurasthenia, or psychoasthenia exist in space? b) Will astronauts or cosmonauts develop asthenia (partial or full) on long-duration space flight missions? c) If asthenia does exist, can it be prevented?

### ***Asthenia Symptom Analysis and Comparison with Depression, Anxiety, Chronic Fatigue, and Psychosomatic Illness***

During this literature review, more than 22 definitions were collected for asthenia: 11 were from the physiology field, six were from the psychiatry/psychology field, and five were used specifically in the space psychology literature. However, it should be noted that all the asthenia or psycho-asthenia definitions utilized for space psychology were Russian<sup>2</sup> (Table 2).

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<sup>2</sup> The only definitions of asthenia in space were described by Russian authors.

**Table 2. Symptoms of Asthenia According to Different Authors**

Symptoms	Reference number																				
	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1	1	2	2
Aggressive tendency										*											
Anxiety symptoms					*		*												*		*
Apathy							*														
Autonomic disturbance							*														
Debility			*	*																	
Decrease in occupational performance					*			*	*	*	*	*	*	*				*			
Deficient mental control			*																		
Depression symptoms (minimal)																		*		*	*
Difficulty concentrating				*	*	*	*	*						*				*		*	*
Dizziness				*														*			*
Drowsiness		*																			
Elevated excitability																		*			
Emotional lability					*						*							*			
Excessive mental strain			*								*	*							*		
Excessive physical strain				*							*	*							*		
Exhaustion											*							*			
Exhaustion after minimal effort					*	*															
Fatigue (non-organic base)	*							*	*	*	*	*	*	*				*			*
Fatigue after mental effort						*	*											*			
Feelings of instability					*																
Headache		*						*										*			*
Heightened sensitivity to bright lights and noises									*									*			
Hopelessness		*																			
Hyperactivity																		*			
Hyperarousal										*									*		
Hyperesthesia													*								
Impatience									*												
Inability to relax						*															
Inefficient thinking						*															
Insomnia			*															*			*
Insufficient power	*																				
Irrascibility																		*			
Irritability						*	*	*	*										*		*
Irritable weakness													*	*				*			

Lack of appetite														*		*
Lassitude															*	
Memory disorder				*	*	*			*					*		
Mental irritability		*														
Morbid fears (phobias)		*														
Muscular aches			*													
Nervous exhaustion			*													
Nervous or mental weakness				*	*											
Pain pressure			*													
Prolonged negative emotional experience				*				*								
Reduced motivation					*											
Requires medical treatment						*										
Sensitivity to external stimuli							*									
Sleep disturbance				*	*	*		*	*					*	*	
Somatic disease				*		*								*	*	*
Symptoms develop after 1 or 2 months							*									
Symptoms develop because of lack of nutrition															*	
Symptoms develop because of adaptive reaction								*	*					*		*
Symptoms don't disappear after rest					*											
Symptoms persist for long time					*							*				
Tearfulness									*		*					
Tiredness					*											
Unstable mood				*				*		*				*		
Vague pain				*												
Weakness	*	*	*	*	*										*	
Worry															*	

We found 62 different symptoms that define asthenia, neurasthenia, or psycho-asthenia. Among all the symptoms, not a single symptom was consistent with all of the definitions that described asthenia, neurasthenia, or psychoasthenia. For that reason, our analysis found that the six most prevalent symptoms were difficulty concentrating, fatigue (non-organic related), sleep disturbance, decrease in occupational performance, somatic disease, and irritability (Table 3). The next most prevalent group of symptoms consisted of weakness, memory disorders, headache, excessive mental strain, excessive physical strain, and symptoms that developed because they were part of an adaptive reaction (Table 4).

**Table 3. Frequency (number of references in Table 2) of the Most Prevalent (primary) Symptoms of Asthenia**

<b>Primary Symptoms</b>	<b>Frequency</b>
Fatigue	9
Sleep disturbance	8
Somatic disease	6
Difficulty concentrating	10
Decrease in occupational performance	7
Irritability	6

**Table 4. Frequency (number of references in Table 2) of the Most Prevalent Secondary Symptoms of Asthenia**

<b>Secondary Symptoms</b>	<b>Frequency</b>
Weakness	5
Memory disorder	5
Headache	4
Excessive mental strain	4
Excessive physical strain	4
Anxiety symptoms	4
Symptoms developed as part of an adaptive reaction	4

G. Beard, the pioneer of asthenia research, wrote in 1880, “As we saw such diversity of symptoms, sensation or conditions cannot properly be thus grouped together to constitute a special and so-called new disease, under any name, not even neurasthenia (...) and maybe [it] is because since the beginning of the neurasthenia definition, the symptoms of neurasthenia have never yet been fully described.” (Beard 1880)

In the second part of our analysis of the asthenia literature, we contrasted asthenia with psychological disorders that historically are associated with it and are presented in different diagnostic systems, including the DSM. These comparisons aim to accept or reject the idea that asthenia is or is not depression, general anxiety, dysthymia, chronic fatigue, or a psychosomatic disorder.

To find out if asthenia is a psychological condition that might arise during a long-duration space mission, we compared common symptoms of asthenia with the current criteria for those psychiatric conditions that are used in different diagnostic systems such as the DSM, ICD, and the Annals of Internal Medicine.

### **Depression**

According to the DSM-IV-TR, to be diagnosed with major depression, it is necessary to present five (or more) symptoms during the same 2-week period, and at least one of the symptoms must be (1) depressed mood or (2) loss of interest or pleasure. Comparing the DSM criteria for depression (Table 5) with the symptoms of asthenia, we found that criteria C, D, and E were met by asthenia. In criterion A, we found three similar symptoms (fatigue, decrease in appetite, diminished ability to think or concentrate). It is necessary to emphasize that the diagnosis of major depression does not match that of the asthenia syndrome in full because of the duration of the symptoms (in the case of depression, only a 2-week period is required). Comparing the ICD-10 criteria for depression with asthenia symptoms, we found four similar symptoms (decreased energy or increased fatigability, diminished ability to think or concentrate, sleep disturbance of any type, and change in appetite). Thus, neither the DMS nor the ICD criteria for major depression were met in full as is evidenced in Table 5 below.

**Table 5. Criteria for a Diagnosis of Depressive Episode, in the DSM-IV-TR and the ICD-10**

Depressive Episode	
DSM-IV-TR	ICD-10 <sup>3</sup>
<p>A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure.</p> <p>1) Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful). <b>Note:</b> In children and adolescents, can be irritable mood.</p> <p>2) markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation made by others)</p> <p>3) significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day. <b>Note:</b> In children, consider failure to make expected weight gains.</p> <p>4) insomnia or hypersomnia nearly every day</p> <p>5) psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down)</p> <p>6) fatigue or loss of energy nearly every day</p> <p>7) feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick)</p> <p>8) diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others)</p> <p>9) recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide</p> <p>B. The symptoms do not meet criteria for a Mixed Episode.</p> <p>C. The symptoms cause clinically significant distress or impairment in social, occupational, or other</p>	<p>The general criteria for depressive episode (F32) must be met.</p> <p>B. At least two of the following three symptoms must be present: (1) depressed mood to a degree that is definitely abnormal for the individual, present for most of the day and almost every day, largely uninfluenced by circumstances, and sustained for at least 2 weeks. (2) loss of interest or pleasure in activities that are normally pleasurable; (3) decreased energy or increased fatigability.</p> <p>C. An additional symptom or symptoms from the following list should be present, to give a total of at least four: (1) loss of confidence and self-esteem; (2) unreasonable feelings of self-reproach or excessive and inappropriate guilt; (3) recurrent thoughts of death or suicide, or any suicidal behavior; (4) complaints or evidence of diminished ability to think or concentrate, such as indecisiveness or vacillation; (5) change in psychomotor activity, with agitation or retardation (either subjective or objective); (6) sleep disturbance of any type; (7) change in appetite (decrease or increase) with corresponding weight change.</p>

<sup>3</sup> <http://www.who.int/classifications/icd/en/GRNBOOK.pdf>

<p>important areas of functioning.</p> <p>D. The symptoms are not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition (e.g., hypothyroidism).</p> <p>E. The symptoms are not better accounted for by Bereavement (i.e., after the loss of a loved one), the symptoms persist for longer than 2 months or are characterized by marked functional impairment, morbid preoccupation with worthlessness, suicidal ideation, psychotic symptoms, or psychomotor retardation.</p>	
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### **General Anxiety**

We found that only criteria D, E, and F for general anxiety disorder in the DSM were similar to asthenia symptoms. Criterion C shares four symptoms with asthenia (easily becoming fatigued or worn out, concentration problems, irritability, and difficulty with sleep). However, the duration of symptoms does not correspond with the time criterion for asthenia. When considering ICD-10, on the other hand, only criterion B was met, with five symptoms corresponding with the asthenia criteria (muscle tension or aches and pains, feeling dizzy, restlessness, inability to relax, difficulty in concentrating, persistent irritability). This evidence corroborates early arguments that asthenia and general anxiety are not similar.

**Table 6. Criteria for a Diagnosis of General Anxiety, in the DSM-IV-TR and the ICD-10**

General Anxiety	
DSM-IV-TR	ICD-10
A. At least 6 months of "excessive anxiety and worry" about a variety of events and situations. Generally, "excessive" can be interpreted as more than would be expected for a particular situation or event. Most people become anxious over certain things, but the intensity of the anxiety typically corresponds to the situation.	A. A period of at least 6 months with prominent tension, worry and feelings of apprehension, about everyday events and problems.
B. There is significant difficulty in controlling the anxiety and worry. If someone has a very difficult struggle to regain control, relax, or cope with the anxiety and worry, then this requirement is met.	B. At least four symptoms out of the following list of items must be present, of which at least one must be from items (1) to (4).
C. The presence for most days over the previous 6 months of 3 or more (only 1 for children) of the following symptoms:	Autonomic arousal symptoms (1) Palpitations or pounding heart, or accelerated heart rate. (2) Sweating. (3) Trembling or shaking. (4) Dry mouth (not due to medication or dehydration).
1. Feeling wound-up, tense, or restless	Symptoms concerning chest and abdomen (5) Difficulty breathing, (6) Feeling of choking, (7) Chest pain or discomfort, (8) Nausea or abdominal distress (e.g., churning in stomach).

<p>2. Easily becoming fatigued or worn-out</p> <p>3. Concentration problems</p> <p>4. Irritability</p> <p>5. Significant tension in muscles</p> <p>6. Difficulty with sleep</p> <p>D. The symptoms are not part of another mental disorder.</p> <p>E. The symptoms cause "clinically significant distress" or problems functioning in daily life. "Clinically significant" is the part that relies on the perspective of the treatment provider. Some people can have many of the aforementioned symptoms and cope with them well enough to maintain a high level of functioning.</p> <p>F. The condition is not due to a substance or medical issue.</p>	<p>Symptoms concerning brain and mind</p> <p>(9) Feeling dizzy, unsteady, faint or light-headed, (10) Feelings that objects are unreal (derealization), or that one's self is distant or "not really here" (depersonalization), (11) Fear of losing control, going crazy, or passing out, (12) Fear of dying.</p> <p>General symptoms</p> <p>(13) Hot flushes or cold chills, (14) Numbness or tingling sensations.</p> <p>Symptoms of tension</p> <p>(15) Muscle tension or aches and pains, (16) Restlessness and inability to relax, (17) Feeling keyed up, or on edge, or of mental tension, (18) A sensation of a lump in the throat, or difficulty with swallowing.</p> <p>Other non-specific symptoms</p> <p>(19) Exaggerated response to minor surprises or being startled, (20) Difficulty in concentrating, or mind going blank, because of worrying or anxiety, (21) Persistent irritability, (22) Difficulty getting to sleep because of worrying.</p>
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### ***Dysthymia***

Five symptoms of DSM-IV-TR dysthymic disorder were similar to those of asthenia: low energy or fatigue, poor appetite or overeating, insomnia or hypersomnia, and poor concentration and feelings of hopelessness. However, the criteria for dysthymic disorders required a duration of 2 years, which does not match the asthenia criteria. Of the ICD-10 criteria for dysthymia, only criterion C had symptoms in common with asthenia, but it had five: insomnia, difficulty concentrating, loss of interest or enjoyment in sex and other pleasurable activities, feeling of hopelessness or despair, and perceived inability to cope with the routine responsibilities of everyday life. But again, because a patient diagnosed with dysthymia needs to have had symptoms continuously for 2 years, we can also conclude that dysthymia and asthenia are not the same.

**Table 7. Criteria for a Diagnosis of Dysthymia, in the DSM-IV-TR and the ICD-10**

Dysthymia	
DSM-IV-TR	ICD
A. Depressed mood most of the day, for more days than not, as indicated either by subjective account or observation by others, for at least 2 years. <b>Note:</b> In children and adolescents, mood can be irritable and	A period of at least 2 years of constant or constantly recurring depressed mood.  Intervening periods of normal mood rarely last for

<p>duration must be at least 1 year.</p> <p>B. Presence, while depressed, of two (or more) of the following: 1) poor appetite or overeating, 2) insomnia or hypersomnia, 3) low energy or fatigue, 4) low self-esteem, 5) poor concentration or difficulty making decisions, 6) feelings of hopelessness.</p> <p>C. During the 2-year period (1 year for children or adolescents) of the disturbance, the person has never been without the symptoms in Criteria A and B for more than 2 months at a time.</p> <p>B. No symptoms have been present during the first 2 years of the disturbance (1 year for children and adolescents); i.e., the disturbance is not better accounted for by chronic, or Major Depressive Disorder, In Partial Remission.</p>	<p>longer than a few weeks and there are no episodes of hypomania.</p> <p>B. None, or very few, of the individual episodes of depression within such a 2-year period are severe enough, or last long enough, to meet the criteria for recurrent mild depressive disorder (F33.0).</p> <p>C. During at least some of the periods of depression at least three of the following should be present: 1) A reduction in energy or activity; (2) Insomnia; (3) Loss of self-confidence or feelings of inadequacy; (4) Difficulty concentrating; (5) Often in tears; (6) Loss of interest or enjoyment in sex and other pleasurable activities; (7) Feeling of hopelessness or despair; (8) A perceived inability to cope with the routine responsibilities of everyday life; (9) Pessimistic about the future or brooding over the past; (10) Social withdrawal; (11) Less talkative than normal.</p>
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### **Chronic Fatigue Syndrome**

Chronic fatigue syndrome is not mentioned nor included as a mental disorder in the ICD-10 nor in the DSM-IV-TR. In our literature analysis we found that, according to a resource document published in the *Annals of Internal Medicine*<sup>4</sup> (Fukuda et al. 1994), chronic fatigue shares three major criteria symptoms (fatigue not due to ongoing exertion, fatigue not substantially relieved by rest, and substantial reduction in occupational, educational, social, or personal activities) and three minor criteria symptoms (self-reported impairment in short-term memory or concentration severe enough to reduce activities, unrefreshing sleep, and muscle pain) with asthenia. However, the criteria for chronic fatigue were not met by asthenia. In addition, the duration of symptoms (6 months) does not correspond with that of asthenia (Table 8).

**Table 8. Criteria for a Diagnosis of Chronic Fatigue, in the *Annals of Internal Medicine* Article and the ICD-10**

Chronic Fatigue	
<i>Annals of Internal Medicine</i> <sup>5</sup> (Fukuda et al. 1994)	ICD
Diagnosis requires all four major criteria and at least four minor criteria (persistent or recurrent during at least 6 consecutive months but not predating fatigue), else considered idiopathic chronic fatigue	Note: There is not a chronic fatigue listing in the ICD-10. Some authors will suggest that chronic fatigue in the DSM is the equivalent of neurasthenia in the ICD. However, the ICD defines neurasthenia differently.
Major criteria: 1) unexplained, persistent or relapsing	

<sup>4</sup>*Annals of Internal Medicine* is an academic medical journal published by the [American College of Physicians](#). The journal had a 2008 impact factor of 16.2, which makes it among the most cited of general clinical medical journals.

<sup>5</sup>Fukuda et al. 1994.

chronic fatigue that is new or of definite onset (not lifelong); 2) fatigue not due to ongoing exertion; 3) fatigue not substantially relieved by rest; 4) substantial reduction in occupational, educational, social, or personal activities.

Minor criteria: 1) self-reported impairment in short-term memory or concentration severe enough to reduce activities; 2) sore throat; 3) tender cervical or axillary lymph nodes; 4) muscle pain; 5) multijoint pain without joint swelling or tenderness; 6) headaches of new type, pattern, or severity; 7) unrefreshing sleep; 8) postexertional malaise lasting > 24 hours; 9) temporary medical exclusions; 10) conditions that can be corrected; for example, medication effects, sleep deprivation, untreated hypothyroidism, untreated or unstable diabetes mellitus, active infection; 11) conditions that resolve; for example, pregnancy until 3 months postpartum, breastfeeding, major surgeries until 6 months post surgery, minor surgeries until 3 months post surgery, major infections until 3 months post resolution; 12) sleep disorders; for example, restless leg syndrome or periodic limb movement; 13) myocardial infarction (resolution may be unclear for at least 5 years); 14) morbid obesity ( $BMI > 40 \text{ kg/m}^2$ )

These are the main conclusions about the foregoing symptom comparisons:

- The *Annals of Internal Medicine* article, the DSM, and the ICD (aside from the fact that they have similar diagnostic criteria with regard to duration of symptoms) have many differences in the way they describe psychiatric pathology.
- Although depressive episodes, anxiety, chronic fatigue, and dysthymia share similar symptoms, they do not share a similarity to asthenia with regard to time and specifically the duration of symptoms.
- It is difficult to define asthenia, neurasthenia, or psycho-asthenia as a psychological syndrome in space, because most space flight missions (excluding many Russian missions) have durations less than or equal to 6 months and most of the symptoms of this syndrome would not necessarily occur in that timeframe.

## **Methodological Approach and Results: Literature Review and Structured Interviews**

To determine the importance of continuing research on asthenia as a possible problem that might affect the optimal psychological functioning of crew members on long-duration space flight missions, it was necessary to do a systematic, extensive international literature review that included conducting structured interviews with experts from around the world. Literature was reviewed from many countries, including Canada, Germany, Spain, Japan, France, Czech Republic, Russia, United States, U.K., Australia, and Switzerland. In addition, subject matter experts were interviewed and represented many countries as well, including Canada, Germany, Spain, Japan, Czech Republic, Russia, and United States.

The comprehensive, systematic literature review had six phases:

- Phase 1: Define inclusion and exclusion criteria.
- Phase 2: Collect relevant articles.
- Phase 3: Conduct initial evaluation of collected articles.
- Phase 4: Conduct structured interviews with experts.
- Phase 5: Analyze and interpret articles and interviews.
- Phase 6: Produce results to develop the final report.

We examined physical, psychological, and psychiatric literature that reported studies involving astronauts and cosmonauts in short- and long-duration space flight missions.

### Inclusion criteria:

1. Sources of documents: scientific journals, conferences, books, magazines, and newspapers, containing reports on empirical or quantitative studies with astronauts and cosmonauts
2. Time period: 1850 to 2010
3. Databases that were searched: PsychInfo, Psycharticle, ISI Web of Knowledge, PubMed, DynaMed, Access Medicine, MD Consult, STATREF, Diagnosaurus, East View Information Services, World Cat, Elsevier, ScienceDirect

Exclusion criterion:

1. Technical reports, books, conferences, newspapers, magazines, dissertations, commentaries, case-samples, and literature reviews that were not representative of astronaut or cosmonaut populations and that were not related to the area of psychology, psychiatry, asthenia, or mental health in long- or short-duration space flight missions

Data collection and analysis: Thirteen major databases (listed above) were examined. The keywords used in the systematic analysis were astronaut(s), cosmonaut(s), asthenia, neurasthenia, neurocirculatory asthenia, psychoasthenia, space, spaceflight, psychology, psychiatry, long duration missions, short duration missions, mental health, chronic fatigue, and trans-cultural diagnosis. The keyword searches identified a total of 345 articles. After the inclusion and exclusion criteria were applied, the final articles for review numbered 104. Six experts from around the world in the fields of psychiatry, psychology (clinical, sport, and neuropsychology), and space medicine, who were either working directly with space agencies that help support astronauts or cosmonauts or were involved in analog projects (like Mars 500) related to space flight missions, were interviewed utilizing a semi-structured framework.

Table 9 provides a summary of those interviewed for this project: a flight surgeon from Russia; a neuropsychologist from Spain; psychiatrists from Canada, New Zealand, and the United States.; a psychologist from Japan; and a sports psychologist from Germany.

**Table 9. Researchers Interviewed for this Project**

Profession/Job Role	Country	Affiliation	Quotation
Flight surgeon	Russia	Russian Federal Space Agency (RFSA)	“...[T]he way we detect the development of symptoms is thorough: body language, the vocabulary they are using, human errors, apathy, etc...”
Neuropsychologist	Spain	European Space Agency (ESA)—Mars 500 mission	“... [I]t’s time to share information about space psychology...”
Psychiatrist	United States	National Aeronautics and Space Administration (NASA)	“...[S]pace flight asthenia is a combination of things that is common to anybody living in an isolated environment...”
Psychiatrist	Canada	Canadian Space Agency	“...[T]here is always a possibility to see psychological symptoms in long duration missions, but I will suspect that the incidence will be very low, because people are very well screened...” ...[O]n the other hand the

			longer somebody is exposed to stress, the more probability is that someone comes with that..."
Psychologist	Japan	Japan Aerospace Exploration Agency (JAXA)	"...[I]n case of an emergency we rely on the USA support..."
Sports psychologist	Germany	ESA — Mars 500 mission	"...[O]ne good countermeasure for asthenia can be exercise..."

### **Asthenia in Space**

From 1961 until June 15, 2010, more than 500 humans from 38 different countries went into space ([http://www.nasa.gov/worldbook/astronaut\\_worldbook.html](http://www.nasa.gov/worldbook/astronaut_worldbook.html)). Despite these numbers and the valuable knowledge and experience gained from those space travels, many psychiatric and psychological questions about space travelers have still not been resolved. These include whether crew members will develop psychological issues or have the mental strength to deal with crew conflict, asthenia, depression, anxiety, and many other psychiatric conditions that will likely occur during long-duration space flight missions. There are several reasons why such questions have not been answered. The main reason seems to be that the psychological well-being of the astronauts or cosmonauts was not the primary goal of the early mission explorations (Santy 1983). Although it has been proved that humans can survive the extremely challenging environment of living in space for a period of weeks, months, or even a year and 10 weeks (the record held by Russian cosmonaut Valeri Polyakov, who completed a 438-day tour of duty aboard the Mir space station in 1995), it is still unknown if humankind can adapt, survive, and perform physically and psychologically on extended-duration missions and/or beyond low Earth orbit.

Despite all the technological, medical, and psychological improvements (such as Internet protocol phones, Internet access, family support packages, and instant communication with ground control) that are available in this new era of space exploration to support astronauts and cosmonauts on long-duration space flight missions, evidence exists that crew members have developed psychological issues (Stuster, 2010) during some of these longer missions. The appearances of these new, unexpected psychological conditions on long-duration space flight missions have concerned space psychiatrists and psychologists. Researchers, primarily from Russia and the United States, have followed these symptoms closely.

Asthenia or neurasthenia is one of the psychological conditions that has been observed, but it has been seen only by Russian medical and psychological personnel (Aleksandrovskiy 1976, Grigoriev et al. 1996, Kanas et al. 2001, Myasnikov & Zamaletdinov 1996) in cosmonauts after they have spent 4 months living in space.

In the mid-1970s, Russian psychiatrists and psychologists considered asthenia a syndrome that should be viewed as an adaptive reaction due to exhaustion of the nervous system as a result of overexertion, lack of proper nutrition, disruptions in intracellular metabolism, and intoxication (Tiganov 1975). However, during this same timeframe, one Russian psychologist defined asthenia as a state characterized by heightened susceptibility to fatigue, fast onset of exhaustion, and partial or total loss of capacity for prolonged physical activity or mental exertion (Tiganov 1975). A year later, Aleksandrovskiy (1976)

stated that asthenia in space develops in three phases: “Stage one (hyperesthesia): there is a general increase in sensitivity to external stimuli, resulting in hyper-arousal and increased (sometimes pointless) activity, emotional instability and irritability, impatience, decreased memory, poor attention and concentration, fatigue, headaches, perspiration, instability of pulse and blood pressure, and sleep disturbances. Stage two: irritable weakness, irritability, and emotional instability progress into more severe fatigue, negative emotional reactions, and somnolence. Stage three: there is indifference and inertness, apathy, constant fatigue, passiveness, and lack of work capability.”

Another contribution to observations of asthenia was made by Petrovsky and Yaroshevsky (1987), who suggested that “asthenia is a nervous or mental weakness manifesting itself in tiredness... and quick loss of strength, low sensation threshold, extremely unstable moods, and sleep disturbance. [Asthenia] may be caused by somatic disease as well as excessive mental or physical strain, prolonged negative emotional experience or conflict.” Years later, Aleksandrovskiy and Novikov (1996) argued that cosmonauts present partial asthenia and it develops after the first or second month of flight. Symptoms included fatigue, decreased work capacity, sleep problems, anxiety, autonomic disturbance, attention and concentration difficulties, and heightened sensitivity to bright lights and loud noises. Furthermore, Myasnikov & Zamaletdinov (1996) defined asthenia as an abnormal state marked by weakness, increased tendency to fatigue, irritability, and disorders of attention and memory, making a clear distinction that asthenia is different from normal fatigue. Myasnikov (2000) in future studies concluded that the asthenia syndrome in space can be identified in three different stages. The first stage is expressed primarily as a heightened emotional excitability; the second stage is characterized by a set of symptoms at the heart of which are mood swings, frequent fatigue, decrease in performance quality, and signs of sleep disturbance; and the third stage is consistently low mood, expressed irritability, conflict tension, hypochondriac phenomena, frequent and significant errors in performing work-related tasks, and expressly manifested sleep disturbances (requiring systematic use of sleep aid medication). Finally, Myasnikov & Zamaletdinov (1996) described the symptoms of asthenia in space as being similar to those affecting patients on the ground, and both versions reflected de-adaptation to a stressful environment. They believed that asthenia in the clinical setting on Earth was a disorder with neurotic features, and it could be treated with medications.

On the other hand, some researchers from the United States. have specifically looked at asthenia in space using the Profile of Mood States (POMS) (Kanas et al. 2001). Kanas and colleagues could not demonstrate the presence of asthenia in space as operationally defined using the POMS, as the POMS addresses only emotional and not physiological aspects of the syndrome (Kanas 1991 & 2003).

Recognition of (and agreement on) psychological symptoms of asthenia before, during, and after long-duration space missions is crucial for psychiatrists, psychologists, flight surgeons, ground control personnel, and astronauts and cosmonauts, as these psychological symptoms can dramatically affect crews’ mental and physical well-being and performance during a mission. These psychiatric and psychological questions will be unresolved until 1) we recognize different diagnoses from different disciplines and countries; 2) we gain more experience with asthenia and more accurately detect, diagnose, and treat it as NASA, ESA, JAXA, and RSFA; and 3) the United States overcomes its lack of long-duration experience.

#### A) Will astronauts and/or cosmonauts develop asthenia?

Beyond the evidence for development of psychological symptoms such as depression, anxiety, and asthenia in astronauts and cosmonauts on long-duration missions (Grigoriev 1996, Myasnikov & Zamaletdinov 1996), only Russian physicians have seen the asthenia syndrome in cosmonauts after 4 months of space flight. NASA flight surgeons, as well as the psychiatrists and psychologists who support the missions, have not observed the symptoms (irritability, sleep disorders, fatigue, difficulty

concentrating, decrease in occupational performance, and some somatic symptoms) of asthenia together to classify them as one syndrome. There are many possible reasons for this, including a) cultural gaps exist in our current diagnostic system (DSM) in the United States and therefore in NASA flight medicine; b) the current environmental and physical condition of the International Space Station has helped to improve the physical and psychological adaptation of the astronauts and cosmonauts; and c) the process for selecting and screening astronauts may have influenced the ability to observe these psychological conditions in U.S. crew members in space. All these factors are possible, but more research is needed to support or refute those arguments.

If we see asthenia as a syndrome or a series of multiple conditions marked by symptoms such as fatigue, irritability, and mood swings (Alexandrovskiy & Novikov 1997, Myasnikov 2000), we cannot predict at this time that future crews will develop the asthenia syndrome on missions of longer duration. However, according to the results of this review, there seems to be a very high probability that at least partial asthenia, as defined by Aleksandrovskiy (1976) and by Alexandrovskiy & Novikov (1997), will develop after 6 or more months in space. And as was discussed above, these questions will remain only partially answered until we send more people on space exploration missions for longer durations.

### B) Can we prevent asthenia in space?

To determine whether asthenia in space is preventable, it was fundamental to establish certain information: 1) a clear definition of the problem or syndrome; 2) what symptoms need to be prevented; and 3) under which circumstances asthenia (that is, weakness, with an increased tendency to have fatigue, irritability, and disorder of attention and memory) appears in space. The first difficulty we encountered in attempting to establish this information was the fact that asthenia is not recognized worldwide as a syndrome or disorder on Earth. This finding complicates the prevention of asthenia in space because we cannot define or know the causes of asthenia. However, we can use the results of the present paper to identify the most frequent symptoms associated with asthenia—fatigue, irritability, sleep disorders, somatic symptoms, difficulty in concentrating, and a decrease in occupational performance. Attempts at preventing asthenia in space can be focused on these symptoms.

Another way in which asthenia could be prevented in space is by addressing the symptoms as they arise in individual astronauts. Russians experts have been addressing prevention in this way for decades. Specifically, they monitor symptoms through an analysis of verbal communication, body language, voice, and tone between crew members as well as between crew members and mission control (Myasnikov et al. 2000). Another possible way to prevent asthenia in space is to examine medical records that may include symptoms such as fatigue, somatic symptoms, sleep quality, and mood (Kanas 2001) as well as general behavior, motor activity, psycho-physiological tension, sensory phenomena, dominant interest, demands and complaints, and emotional reactions. At the group level, one can analyze job performance, group interaction, group cohesiveness, intergroup control, and group functioning (Myasnikov & Zamaletdinov 1996).

We can also use international assessment tools that have been used in disciplines outside the fields of psychiatry, psychology, and space psychology, such as paper-based survey tools that assess asthenia in populations such as cancer patients (Morant et al. 1993), but it is likely that these questionnaires would need to be customized for astronauts and cosmonauts to ensure they are valid and sensitive to this unique population. Another countermeasure for asthenia could be exercise (S. Schneider, personal communication, June 2010). Lastly, we could use antiasthenic medication (Gordeev et al. 2003).

## Conclusions

With this report, the BHP Research Element has addressed one of the recommendations made by the NASA HRP SRP for the Behavioral Medicine Risk of Psychiatric Disorders, specifically the recommendation to complete an evaluation of the “literature on asthenia …(possibly as a psychological or psychosomatic/psycho-physiological analogue of chronic fatigue syndrome).” This report makes this Element aware of the possible existence of asthenia in space. As the report describes, the concept of asthenia has been adopted and modified on the basis of subjective experience by cultures around the world, making asthenia a difficult concept to define, and therefore also difficult to diagnose. Nevertheless, countries like China, Japan, Russia, Germany, and Switzerland still consider asthenia to be a psychiatric condition, although the United States does not.

The subjectivity in the definition of asthenia has produced new lines of research on clinical disorders and descriptions of them. In addition, asthenia has been compared with other psychiatric conditions, but there is enough evidence to show that asthenia is a psychopathology on its own, even if asthenia syndrome shares some symptoms with other psychopathologies like dysthymia, major depression, anxiety, and chronic fatigue (Gamma et al. 2007, Goldberg & Bridges 1991, Harvey et al. 2009, Kleinman 1982).

Despite the fact that the United States and Russia are the most experienced countries in sending astronauts and cosmonauts into space and supporting them, only the Russian program recognizes asthenia, neurasthenia, or psycho-asthenia as a possible threat during long-duration missions. This is likely due to many reasons, but one reason may be that the Russian space program has more experience sending cosmonauts into space for missions of the longest durations so far (6 months or more). The United States has limited experience on space flight missions beyond 6 months, and thus has limited observations of psychological symptoms that may be experienced during missions of such duration.

It seems that the experience of isolation and deprivation that crew members can face on missions of less than 6 months is completely different from this experience on missions of more than 6 months. On missions shorter than 6 months, psychological symptoms seem unlikely to develop. On the other hand, on missions longer than 6 months in space, it is possible to observe symptoms of depression, fatigue, and general anxiety and asthenia. According to Russian personnel (those who were interviewed), asthenia symptoms will develop after 4-month missions; if this is the case, NASA would have a limited window to observe if, when, and how those symptoms would develop in the astronaut population.

In the literature review, we found that not a single symptom was present in all the definitions that describe asthenia or neurasthenia. However, some symptoms were more prevalent than others in these definitions. The most prevalent symptoms that were found in definitions of asthenia were difficulty concentrating, fatigue (non-organic related), sleep disturbance, decrease in occupational performance, somatic disease, and irritability. The next most prevalent symptoms were weakness, memory disorders, headache, excessive mental strain, excessive physical strain, and symptoms that developed as part of an adaptive reaction.

When we compared asthenia with depression, dysthymia, general anxiety, and chronic fatigue, we found that although chronic fatigue has most of the same symptoms as asthenia, asthenia does not share the criterion of duration (a patient must have the symptoms of chronic fatigue for 6 months to meet the diagnosis criteria). Thus, we can state that asthenia is not chronic fatigue. However, if asthenia symptoms continued for more than 6 months, we could make the argument that astronauts and cosmonauts were experiencing chronic fatigue syndrome and not asthenia.

## Recommendations

After doing a comprehensive international literature review on asthenia, we are open to the possibility that asthenia symptoms occur in astronauts on long-duration missions; however, because a gap exists in our diagnostic system (DSM), we were unable to identify these symptoms as one syndrome called asthenia. To answer that question, future research is needed, and the most important need is to have more experience on long-duration missions (6 months to 2 years). To determine whether astronauts or cosmonauts develop asthenia in space, the authors suggest that the following steps would be necessary:

1. The United States (including NASA) would determine the duration of the symptoms of asthenia (as defined by others) in astronauts, and then try to identify the context within which these symptoms occur—the frequency of symptom development and the conditions that seem to be associated with the development of symptoms in individuals.
2. Research would have to be conducted to produce a clear definition of what asthenia is, what its symptoms are, and what causes it. Once NASA has collected data on the epidemiology of the symptoms, how they present in individual astronauts, and under what conditions they seem to occur, then NASA researchers would begin to explore the etiology of the syndrome.
3. An effort to diagnose and prevent asthenia and other psychological symptoms during space missions would need to be done through international cooperation; thus a transcultural diagnosis would be necessary. As professionals in the field of space psychology and psychiatry, we have to remember that culture does influence the manifestation of disorders. Therefore, one route to follow would be to see what asthenia symptoms look like and how individuals think about the symptoms and experience of the disorder. We would have to explore those symptoms in the U.S. cultural context first, and then the syndrome as evidenced in U.S. astronauts could be compared to the way it develops and presents itself in Russian cosmonauts and any other travelers in space.
4. This research would need to include astronaut (U.S., Canadian, Japanese, and European) and cosmonaut participants who would be in space for long periods, to see what kind of psychological symptoms would develop and investigate the reasons for their development (for example, microgravity, increased exposure to radiation, and changes in levels of carbon dioxide).
5. This research would also need to address whether asthenia or neurasthenia in space happens as a consequence of environmental factors such as exposure to radiation, interior lighting, isolation, microgravity, or changes in levels of carbon dioxide, or if it is due to individual differences or other psychological factors.

At this time, the existence of asthenia in long-duration space missions has still not been proven. As we saw in our comparative analysis, however, an alternative approach to determine psychological factors in long-duration missions would be to focus on conditions that involve affect, cognition, and behavior. If the focus is put on identifying factors related to these psychological functions, this specificity will help us to detect symptoms early, and this could prevent such conditions as asthenia and thus affect the mental and physiological performance of the crew. Other ways to prevent asthenia would include more focused attention on the six most frequent symptoms identified in the analysis described above (difficult concentration, fatigue [non-organic related], sleep disturbance, decrease in occupational performance, somatic disease, and irritability) and use of scientific tools and assessments to identify changes in those areas.

In sum, we believe that asthenia is a good example of a syndrome or condition that can lead to more research in the new field of space psychology. Future research on space psychological factors that might arise in long-duration space flight missions (1 year or longer) is needed as well as international collaboration to determine a transcultural diagnosis of asthenia or other psychological pathologies.

“I think the human race has no future if it doesn't go into space.”

—Stephen Hawking (2007)

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<p>13. ABSTRACT (<i>Maximum 200 words</i>)  The aim of this report is to address a recommendations made by the NASA Human Research Program Standing Review Panel that the “literature on asthenia should be evaluated (possibly as a psychological or psychosomatic/psycho-physiological analogue of chronic fatigue syndrome)”, in addition to General Recommendation 4, which states that “all reviews must include non-English language materials as well as materials appearing in conferences reports, books, and other non-refereed journal outlets”. This report was a collaborative international work effort focused on the evaluation and determination of the importance of continuing research on asthenia as a possible psychological problem that might affect the optimal psychological functioning of crew members during long-duration space flight missions. This report describes the definitions of asthenia that exist by examining the current literature on this topic, then summarizes interviews that were conducted to represent the different multicultural perspectives of this issue. Conclusions and recommendations specific to both the literature review and the interviews are then discussed.</p>			
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