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Psychophysiology of Spaceflight

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In space, the absence of gravity alone causes unique physiological stress. Significant biomedical changes, across multiple organ systems such as body fluid redistribution, diminished musculoskeletal strength, changes in cardiac function and sensorimotor control have been reported. The time course of development of these disorders and severity of symptoms experienced by individuals varies widely [1]. Space motion sickness (SMS) is an example of maladaptation to microgravity, which occurs early in the mission and can have profound effects on physical health and crew performance. Disturbances in sleep quality, perception, emotional equilibrium and mood have also been reported, with impact to health and performance varying widely across individuals. And lastly, post-flight orthostatic intolerance, low blood pressure experienced after returning to Earth, is also of serious concern. Both the Russian and American space programs have a varied list of human errors and mistakes, which adversely impacted mission goals [2 and 3]. Continued probability of human exposure to microgravity for extended time periods provides a rationale for the study of the effects of stress [4 and 5]. Our research group has aimed at examining individual differences in: (a) prediction of susceptibility to these disorders, (b) assessment of symptom severity [6], (c) evaluation of the effectiveness of countermeasures [7], and (d) developing and testing a physiological training method, Autogenic-Feedback Training Exercise (AFTE) as a countermeasure with multiple applications [8-12].

The present paper reports on the results of a series of human flight experiments with AFTE aboard the Space Shuttle and Mir Space Station. Data were collected on 6 crewmembers during two separate shuttle flights (3 treatment and 3 controls) [13 and 14]. Of the three crewmembers given AFTE (no medications), two were symptom-free while one experienced only one minor symptom episode on the third mission day. Of the three control group subjects, however, who took a variety of anti-nausea medications, two experienced multiple vomiting episodes, the first occurring within 10-minutes of orbit insertion. For these crewmembers, severe to moderate symptoms persisted over 4 mission days while the third control subject experienced only minor symptoms on the first day in space (Cowings, et. al, 1988; Toscano & Cowings, 1994). These findings suggest that AFTE might be a successful countermeasure for space motion sickness.

A study aboard the MIR space station was designed to study individual characteristics of adaptation (i.e., autonomic responses) to long duration spaceflight and possibilities of their correction using an AFTE) [15-17]. Of primary interest was the effect of AFTE on post-flight orthostatic tolerance. Two male cosmonauts were given 6 hrs of preflight

AFTE and tested for orthostatic tolerance to head-up tilt. Physiological responses were measured pre- and postflight and on 8 of the 208 flight days. Subject A's autonomic control during flight was comparable to his preflight performance, while subject B showed less consistent control. Postflight orthostatic tolerance of subject A improved relative to his earlier flight, while subject B was presyncopal within 14 minutes, a result that was similar to his previous flight.

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