

Sleep Deprivation Effects on Human Functional State

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The effects of chronic stress induced by sleep deprivation were examined in a recent study. Interest in behavioral issues is increasing as the emphasis in the US space program shifts from brief flights to long duration shuttle flights, space station missions, and the possibility of human explorations of other planets. It is possible that exposure to the chronic stress associated with long-duration missions will lead eventually to fatigue, physical, and emotional exhaustion. Acute stress might lead to a hyper-reactive physiological state that will negatively impact crew performance. Behavioral guidelines, training protocols, selection procedures and other countermeasures will play a central role in multidisciplinary efforts to maximize crew psychological health, well being and productivity in space.

The present study utilized a multi-factorial approach to examine the effects of chronic stress induced by 36 hours of sleep deprivation on neurobehavioral functions in two, healthy, young men and one woman. Their performance was assessed using a standard test battery that included a combination of cognitive, perceptual, and neuromotor tasks. Data were collected at 2-hour intervals while the participants' physiological responses were continuously monitored. A composite performance score was derived from the raw data of seven subtests. Composite performance scores were then used to convert performance decrement data to blood alcohol level equivalency percentages (BAL%), based upon previous studies which showed linear relationships between BAL% levels and percent performance decrements. Additional measures were obtained on subjective mood states and self-ratings of physical symptoms. All mood and performance metrics showed negative effects as a function of increased sleep loss. Performance decrements during sleep deprivation primarily resulted from increases in response latencies rather than changes in error rates. Figure 1 shows changes in performance expressed as BAL%'s plotted over time for each subject. Performance percent decrements were detected during sleep deprivation, which were equivalent to BAL% above 0.08, which is the legal limit of alcohol consumption in most states. This indicates that the observed performance decrements induced by sleep deprivation had implications for significant impairment in operational performance capacities. Physiological data paralleled performance and were directly related to individual differences in susceptibility to chronic stress induced sleep loss. Lower heart rates were associated with deterioration in specific mood states such as decreased arousal levels and greater physical discomfort (Figure 2). The methodology of multiple converging indicators may be a useful assessment tool for studying the effects of chronic stress on crew functional state during extended spaceflight.