

A Countermeasure for Space Motion Sickness

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Overall, the results obtained in both the U.S. and the Russian space programs indicate that most space crews will experience some symptoms of motion sickness (MS) causing significant impact on the operational objectives that must be accomplished to assure mission success. At this time the primary countermeasure for MS requires the administration of Promethazine. Promethazine is not a benign drug, and is most frequently administered just prior to the sleep cycle to prevent its side effects from further compromising mission objectives. Clearly other countermeasures for SMS must be developed. Currently the primary focus is on two different technologies: (1) developing new and different pharmacological compounds with less significant side effects, (2) preflight training. The primary problem with all of these methods for controlling MS is time. New drugs that may be beneficial are years from testing and development, and preflight training requires a significant investment of crew time during an already intensive pre-launch schedule. Granted, motion sickness symptoms can be minimized with either of the two methods detailed above, however, it may be possible to develop a countermeasure that does not require either extensive adaptation time or exposure to motion sickness.

Approximately 25 years ago Professor Geoffrey Melvill Jones presented his work on adaptation of the vestibulo-ocular reflex (VOR) using optically reversed vision (left-right prisms) during head rotations in the horizontal plane. It was of no surprise that most subjects experienced motion sickness while wearing the optically reversing prisms. However, a serendipitous finding emerged during this research showing that the same subjects did not experience motion sickness symptoms when wearing the reversing prisms under stroboscopic illumination. The mechanism, by which this side-effect was believed to have occurred, is not clearly understood. However, the fact that *no motion sickness* was ever noted, suggests the possibility of producing functionally useful adaptation during space flight without the penalty of disabling motion sickness by controlling the rate of the adaptive process by means of an appropriate stroboscopically presented environment.

After several recent meetings with Professor Melvill Jones, we were encouraged to repeat the motion sickness portions of his and Mandl's 1981 stroboscopic experiment. In conducting this experiment we used a randomized cross-over design where subjects were randomly assigned to either a stroboscopic flash or no strobe for their first exposure in the experimental design. Twenty subjects (19 subjects completed the study) read a short passage from *Treasure Island* mounted on the wall approximately 1 m from their eyes while wearing left-right reversing prisms. The strobe on time of 3 μ sec and flash frequency of 4 Hz was set to equal that used in the original study. Motion sickness was scored using a modified Miller and Graybiel scale that we constructed to include symptoms that may be elicited under conditions where reversing prisms are worn. On this scale a score of 5 represented Malaise IIa (mild motion sickness) and a score of 8 or above is approaching frank sickness. Symptoms were tracked and recorded every 5 min during the task. Testing was limited to 30 min unless the subject had reached the MIIa score, at which time the test was terminated. Performance under stroboscopic illumination was significantly better than when the subjects read under normal room illumination while wearing the left-right reversing prisms. Based on these results we developed a goggle system using LCD material that can be "strobed". To evaluate the effectiveness of stroboscopic goggles we tested an additional 9 subjects in addition to retesting 10 used in the stroboscopic pilot study described above. These 19 subjects wore a pair of "strobing" LCD goggles that could be cycled at 4 Hz. These subjects wore the goggles while also wearing left-right reversing prisms. Results while wearing the goggles showed that none of the 19 subjects scored at the MIIa level on the motion sickness rating scale. When the goggles did not flash (no strobe), 11 of the 19 developed symptoms above the MIIa criteria.

As a countermeasure the goggles seem to be effective, even with an on time of 10 msec (time the goggles are clear). We have also collected anecdotal data, from our personnel in the Neuroscience Laboratory at the Johnson Space Center, suggesting that the goggles may be effective in preventing carsickness.