

STROBOSCOPIC VISION AS A TREATMENT FOR SPACE MOTION SICKNESS

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INTRODUCTION

Results obtained from space flight indicate that most space crews will experience some symptoms of motion sickness causing significant impact on the operational objectives that must be accomplished to assure mission success. Based on the initial work of Melvill Jones we have evaluated stroboscopic vision as a method of preventing motion sickness. Given that the data presented by professor Melvill Jones were primarily post hoc results following a study not designed to investigate motion sickness, it is unclear how motion sickness results were actually determined. Building on these original results, we undertook a three part study that was designed to investigate the effect of stroboscopic vision (either with a strobe light or LCD shutter glasses) on motion sickness using: (1) visual field reversal, (2) Reading while riding in a car (with or without external vision present), and (3) making large pitch head movements during parabolic flight.

METHODS

Visual Field Reversal Testing. Nineteen subjects read text while making $\pm 20^\circ$ head movements in the horizontal plane at 0.2 Hz while wearing left-right reversing prisms during exposure to 4 Hz stroboscopic or normal room illumination. In a simple crossover design, testing was repeated using LCD shutter glasses as the stroboscopic light source with an additional 13 subjects and 6 subjects from the first condition (for a total of 19 subjects). *Car Reading.* The protocol for motion sickness provoked in a moving car with the subject reading an adapted version of *Treasure Island* was conducted in two phases: (1) outside view occluded (9 subjects), and (2) normal outside view (10 subjects). In both phases subjects were tested with the glasses either flashing or not flashing with a minimum of 1 week between tests. *Parabolic Flight.* Nine subjects flew on two flights separated by at least 5 weeks. Treatment was either flash or no flash on a specific flight while subjects made whole upper body pitch movements and viewed the surrounding plane's interior during the μg portion of the parabola (subjects were seated and stationary during all other phases of flight). *Scoring.* Motion sickness was scored using a modified Pensacola Diagnostic Index (PDI) and subjective self-ratings.

RESULTS

Visual Field Reversal Testing. During the experiment with a strobe light, motion sickness scores were significantly lower than in the control condition where normal room illumination was used. Results with the LCD shutter glasses were analogous to those observed when the environment was strobed in an otherwise dark room. In both test environments all subjects (total of 38) completed the 30 min end criteria under both stroboscopic conditions, while only half of the subjects (total of 19) completed the full 30 minutes of testing under the control condition. *Car Reading.* Three of the 9 subjects in the outside view-occluded condition completed the 30 min car ride during both the treatment and control test sessions. Of the remaining 6 subjects, all but one showed an increase in tolerance time to motion while reading under stroboscopic illumination. For testing in which the outside view was not occluded, two of the 10 subjects completed the 30 min testing session during both the control and treatment sessions. Another two subjects were susceptible regardless of the treatment (terminated the test within 6 to 7 min), one subject performed worse under strobe, and the remaining 5 subjects demonstrated a significant increase in tolerance time while reading under stroboscopic light. *Parabolic Flight.* Under stroboscopic illumination, four of the 9 subjects showed no change in susceptibility, one subject completed fewer parabolas while under stroboscopic illumination (32 parabolas vs. 35), and the remaining four subjects demonstrated an increased tolerance to the μg portion of the flight. It is interesting to note that more motion sickness may have been attributable to the hyper-g phase of flight where the subject sat with eyes closed and made no pitch head movements, than to the μg phase when the subjects were actually moving relative to the plane.

CONCLUSION

Stroboscopic illumination reduces the severity of motion sickness symptoms, and shutter glasses with a flash frequency of 4 or 8 Hz with a short dwell time are as effective as a strobe light. Stroboscopic illumination appears to be an effective countermeasure where retinal slip is a significant factor in eliciting motion sickness. Furthermore, the results suggest the possibility of producing functionally useful adaptation via stroboscopic illumination during space flight without the penalty of disabling motion sickness by controlling the rate of the adaptive process.