

GALVANIC VESTIBULAR REDUCTION MODIFIES PERCEPTION OF CORIOLIS CROSS-COUPLING AND DELAYS MOTION SICKNESS ONSET

G. N. Pradhan ¹, M. J. Cevette ¹, J. M. Bogle¹, J. Stepanek ¹ and S. J. Wood ²

¹ Mayo Clinic, Scottsdale, AZ and ² NASA Johnson Space Center, Houston, TX

INTRODUCTION: Alterations in vestibular sensory processing following G-transitions lead to head movement sensitivity and motion sickness upon return to Earth's gravity. The purpose of this study was to evaluate whether a non-pharmaceutical tool using galvanic vestibular reduction (GVR) could suppress disorienting illusions and mitigate motion sickness. A similar approach using anodal (inhibitory) currents delivered to both ears has been shown to result in a selective reversible ablation of irregular vestibular afferents [1].

METHODS: Using a repeated measures counter-balanced design, motion sickness and perception were obtained in 26 subjects during Coriolis cross-coupling stimuli on a rotating chair across three GVR treatment interventions: throughout stimulus testing (prevention), following symptom onset (rescue), and placebo control. The GVR peak current was maintained at 2.5 mA across subjects and across prevention / rescue sessions. Subjects performed up to 10 sets of pitch head movements during constant rotation. For each set, head movement was cued every 10 seconds, alternating between pitch forward (chin resting to chest) and pitch backward (head upright) for a total of 7 forward and backward movements. During each head movement, subjects were asked to use a joystick to record the magnitude of their perceived rotation along three axes. During the 2-minute pause between sets, motion sickness symptom scoring was obtained using the Pensacola Diagnostic Index and subject discomfort (0-20) ratings. Performance on a sensorimotor and cognitive test battery was measured during a fourth session to map changes in GVR level with functional performance.

RESULTS: Fourteen of the 26 subjects were not susceptible to the motion stressor (i.e., did not reach an endpoint in the control condition). While the time to endpoint, or number of head movements, did not significantly vary across the three GVR conditions in the remaining subjects, the symptom levels were significantly lower through the third set of head movements when GVR was on throughout the testing. Initiating GVR following symptom onset did not appear to alter the symptom progression nor time to motion sickness endpoint. Based on the joystick measures, GVR significantly modified the perceived roll and pitch sensation during head movements, reducing the amplitude of tilt in most subjects. It is important to note that comparable levels of GVR did not impair performance on a functional test battery including mobility, balance and cognitive tasks.

DISCUSSION: Our findings suggest GVR may be useful in reducing disorienting roll and pitch illusions and delaying the onset of motion sickness. Further enhancements will be required to individualize the stimulation amplitude and optimize the waveform delivery. Adapting this non-pharmaceutical countermeasure approach to allow self-administered titration of current amplitude during recovery would enable transfer to post-flight treatment of motion sickness.

[1] Minor L. B. and Goldberg J. M. (1991) J Neurosci 11, 1636-48. 109, 889-894.