Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **2008**	2. REPORT TYPE	3. DATES COVERED **00-00-2008 to 00-00-2008**

4. TITLE AND SUBTITLE **Mitigating Motion Sickness in Ground Vehicles**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Research Laboratory,4555 Overlook Avenue SW,Washington,DC,20375**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**2**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Mitigating Motion Sickness in Ground Vehicles

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Introduction: Motion sickness (MS) represents a challenge to many warfighters, particularly those in command and control vehicles (C2V). Research by the U.S. Army and NASA[1] suggests that as many as 90% of operators in a C2V experience some performance decrements and MS symptoms. Common solutions to MS emphasize pharmacological interventions, such as promethazine and dimenhydrinate (Dramamine™). The challenge with these approaches is that they often lead to decrements in cognitive performance and drowsiness. The sensory conflict theory suggests that MS arises in conditions where the sensory systems, specifically the visual and vestibular systems, detect different motions. This paper provides evidence for an information technology solution to MS, called Motion Coupled Visual Environment (MOCOVE),[2] which attempts to resolve MS by artificially introducing couplings between visual and vestibular motion cues.

The MOCOVE device contains a set of accelerometers that detect physical motion and uses software to provide an Earth-referenced, stabilized viewing scene. For example, when MOCOVE accelerometers detect a roll movement of the vehicle, MOCOVE software rotates the computer display window in the opposite direction, at a rate proportional to the rate of physical rotation of the vehicle. Similarly, if MOCOVE accelerometers detect an upward movement of the vehicle (usually called heave), then MOCOVE software acts to move the display window downward proportionally.

Previous research demonstrated the potential for using MOCOVE to reduce MS in a ship motion simulator (SMS). Participants viewed motions with and without MOCOVE as the SMS provided pitch and roll motions. Due to technical issues with the sensors, all participants on day one did not have MOCOVE, while on day two they had MOCOVE. Initial results, which used the motion sickness assessment questionnaire (MSAQ) scores collected at 5-minute intervals during the study, suggested a reduction in MS symptoms on day two supporting MOCOVE. However, it is not clear if this difference was potentially due to adaptation to the environment. The current study was designed to determine (a) how effective MOCOVE is in a moving ground vehicle (see Fig. 1) and (b) the extent to which repeated exposure will affect MS and performance.

FIGURE 1
MOCOVE test vehicle.

Methodology and Results: The experiment was conducted at the United States Military Academy (USMA), West Point, NY, with 21 first-year cadets participating in the study. Each participant took part in training and two driving sessions. The first driving session could be held on the same day as the training, but the final driving session had to be held on a subsequent day. The two driving sessions were identical except that half the participants had MOCOVE on the first day and the other half had the uncoupled system on the first day.

Participants received approximately 1 hour of training on a cognitive-motor battery and a simplified C2V task prior to entering the vehicle. Data were collected from the participants before the vehicle began moving, twice during each drive, and immediately after the completion of each drive (Fig. 2).

The data indicated a significant difference decrease in participants' ratings of MS on the first day compared to the second day. While there was no overall difference between MOCOVE and the uncoupled system, further analysis found that the difference between the two systems was significant on the first day.

Summary: The study provided some evidence of the effectiveness of MOCOVE in reducing motion sickness symptoms. More importantly, the current results appeared to be influenced by the more powerful effect of previous exposure (i.e., on the previous day). This pattern of results was unexpected because adaptation to MS at sea typically requires hours or days of continuous, prolonged exposure. The present study provides some initial data for adaptation to MS in ground vehicles with uncoupled motions; however, future research needs to examine this issue further.

The MOCOVE effect may have been weaker than expected because the system used in the current experiment was a modified version of the system designed for ship motions, which are characterized by movement along the rotational axis (i.e., pitch and roll) and

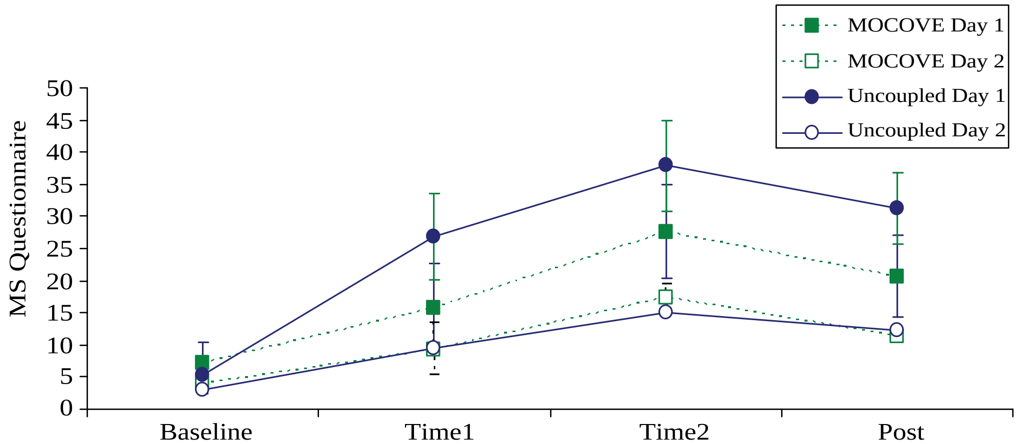

FIGURE 2
Motion sickness self-report data.

not lateral movement (i.e., accelerating and braking). There is some indication in the literature that it is these motions (braking/acceleration) that contribute most to motion sickness in land vehicles, and it is possible that the MOCOVE system being used could not adequately compensate for them. Design of a new ground vehicle–specific version of MOCOVE is already under way. This new design will feature a static window where the operators will perform their tasks while the background of the display will feature a moving terrain depiction based upon the vehicle's motion. It is hypothesized that this display may have a more pronounced reduction of MS.

[Sponsored by ONR]

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