



Cybersickness, Console Video Games, & Head Mounted Displays

Lesley Scibora, Moira Flanagan, Omar Merhi,
Elise Faugloire, & Thomas A. Stoffregen



Affordance Perception-Action Laboratory,
University of Minnesota, USA



Motion Sickness

- Not restricted to inertial motion environments, also commonly found in virtual motion environments;
- Common in systems that depict motion of the user, whether real or illusory.
- Effectiveness of simulation and acceptance by users can be limited if they produce this type of sickness, termed visually induced motion sickness, or *cybersickness*; a strong practical motivation for understanding the malady.



Cybersickness

- Virtual environments consist of visual simulations, which have been found to evoke *cybersickness* in some users.
- Positive correlation between technical sophistication of visual simulation and the incidence of cybersickness among users.
- Virtual environments often involve a number of perception-action tasks, which resemble video games.
- Highlights the importance of behavioural research on how people interact in simulated environments.



Motion Sickness Etiology

- Theories typically based on the concept of *sensory conflict*
 - Sickness situations characterized by patterns of stimulation that differ from those expected on the basis of past experience, interpreted as sensory conflict, alleged to produce sickness
 - But... low predictive validity; may not be scientifically falsifiable
- We sought to evaluate an alternative theory, the *postural instability* theory of motion sickness:
 - Sickness preceded by instabilities in the control of bodily orientation, necessary and sufficient for the occurrence of sickness
 - Does not attempt to explain the symptoms of sickness, but just that the symptoms do not arise from sensory conflict



Commercial Console Video Games

- One area of rapid technological development in virtual environments is console video games, such as *Play Station*, and *Xbox*.
- Studies have shown that sickness can occur when users participate in virtual environments that resemble commercial console video games, however...
 - In most cases, commercially available console video games were not utilized but, instead game-like situations were created specifically for research.
 - Relative to game-like situations used in previous laboratory experiments, commercial console video games tend to have greater realism, faster update rates, and more content-related decisions and interactions.



Experimental Rationale

- We sought to test the hypothesis that postural instability will precede sickness in the context of commercial console video games.
- We collected data on body movement prior to the onset of sickness, and we tested the hypothesis that, prior to the onset of subjective symptoms of sickness, movement would differ between participants who eventually became sick, and those who did not.



Methods

- **Participants**
 - N = 33 (13 women, 20 men)
- **Apparatus**
 - We used a standard Xbox system (Xbox 2, Microsoft Corp.)
 - Games played: *Whacked* or *Halo*, players control motion through a virtual world.
 - Presented on an HMD (VisettePro), a bi-ocular VGA system.
- **Movement assessment**
 - We used a magnetic tracking system to collect movement data on the head and torso
- **Sickness assessment**
 - Sick and Well groups were formed based on explicit verbal statements from participants
 - Sickness symptoms were quantified using the SSQ, administered pre- and post-experiment.



Methods...

- **Procedure**
 - Game play lasted for up to 50 minutes, however, the experiment was immediately stopped when the participant reported the onset of sickness.
 - Post-experiment SSQ was completed immediately after game play, or from forms returned after 24 hours



Methods ...

- **Independent Variables**
 - Condition
 - *Standing versus Sitting*
 - Game
 - *Whacked versus Halo*
 - Group
 - *Sick versus Well*
- **Dependent Variables**
 - Cybersickness
 - *Incidence*
 - *SSQ Total Severity Score*
 - *Separate pre-test and post-test scores*
 - Movement
 - *Head and torso (Antero-posterior (AP), medio-lateral (ML), & vertical)*



Results

- **Cybersickness Incidence**
 - *Standing versus Sitting*
 - A significant effect of Condition (sitting-standing) on susceptibility to motion sickness among users of console video games.
 - *Whacked versus Halo*
 - No significant effect of Game on susceptibility to motion sickness among users of console video games.

	<i>N - Total</i>	<i>N - Sick (Incidence)</i>	<i>Sick Latency (min)</i>
<i>Whacked - Standing</i>	7	7 (100%)	17
<i>Whacked - Sitting</i>	17	10 (59%)	14
<i>Halo - Sitting</i>	9	8 (89%)	16

Table 1. Mean latency and incidence of motion sickness.



Results

o **Symptom Severity**

- **Standing versus Sitting**
 - No significant effect of Condition in either Trial
 - Sitting down ↓ incidence of sickness, not severity
- **Whacked versus Halo**
 - No significant effect of Game for either Group, in either Trial
- **Pre- versus Post-**
 - A significant effect of Trials with increased severity of symptoms following game play
- **Sick versus Well**
 - No significant effect of Group in either Trial



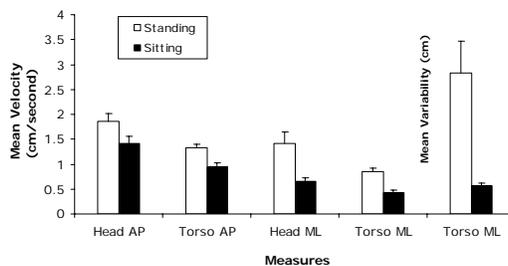
Results

o **Movement data**

- **Standing versus Sitting**

A significant effect of Condition upon:

- Velocity of head and torso motion; ML variability of torso movement.
- Movement was greater in the Standing condition than in the Sitting condition.



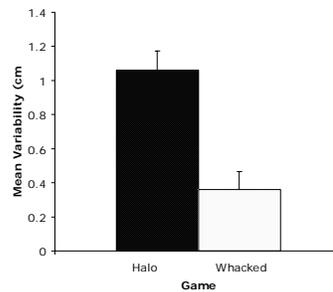


Results

○ **Movement data**

● *Halo versus Whacked*

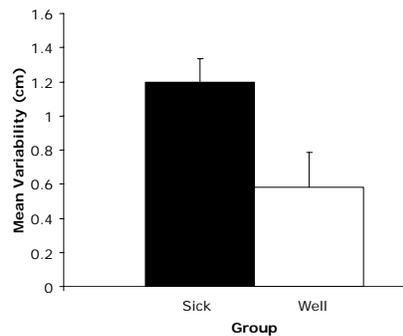
- Within the Sick participants, there was a significant effect of Game upon variability of head movement in the ML axis.
- When playing *Halo*, participants who later became motion sick exhibited greater ML head movement than participants playing *Whacked* who later became sick.



Results

● *Sick versus Well*

- A significant effect of Group upon:
 - variability of head movement in the vertical axis.





Discussion

○ **Cybersickness**

- Sickness can occur among users of commercially available console video games.
- Post-test SSQ scores were higher than pre-test scores for both Sick and Well groups.
- Incidence of sickness was high during the standing condition, significantly lower when seated.
 - This difference, as a function of posture, may have implications for theories of motion sickness etiology.

○ **Postural Instability**

- We found a difference in head motion between participants who did not report motion sickness and those who did.
 - Variability of vertical head motion was greater among participants who later became sick than among those who did not.
- This difference supports the postural instability theory of motion sickness, suggesting that differences in body movement related to the incidence of motion sickness were present throughout game play.



Conclusions

- Our finding of sickness among users of commercially available console video games is consistent with anecdotal reports from game users.
 - The popularity of console video games provides a motivation for research that may permit us to gain control of cybersickness among users; to predict and to prevent.
 - Prediction might be achieved through monitoring of players' movements during game play. Online analysis of movement data might make it possible to identify individuals who are at-risk for cybersickness; such persons could be advised of the risk and encouraged to discontinue their activity.
- Our present results confirm that postural instability precedes motion sickness, and extends this finding to the seated use of a head-mounted display.



Thank you

- Questions?

- Acknowledgements

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