

# Head Tilt and its effects on Cybersickness Incidence In Head Mounted Displays



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## Introduction

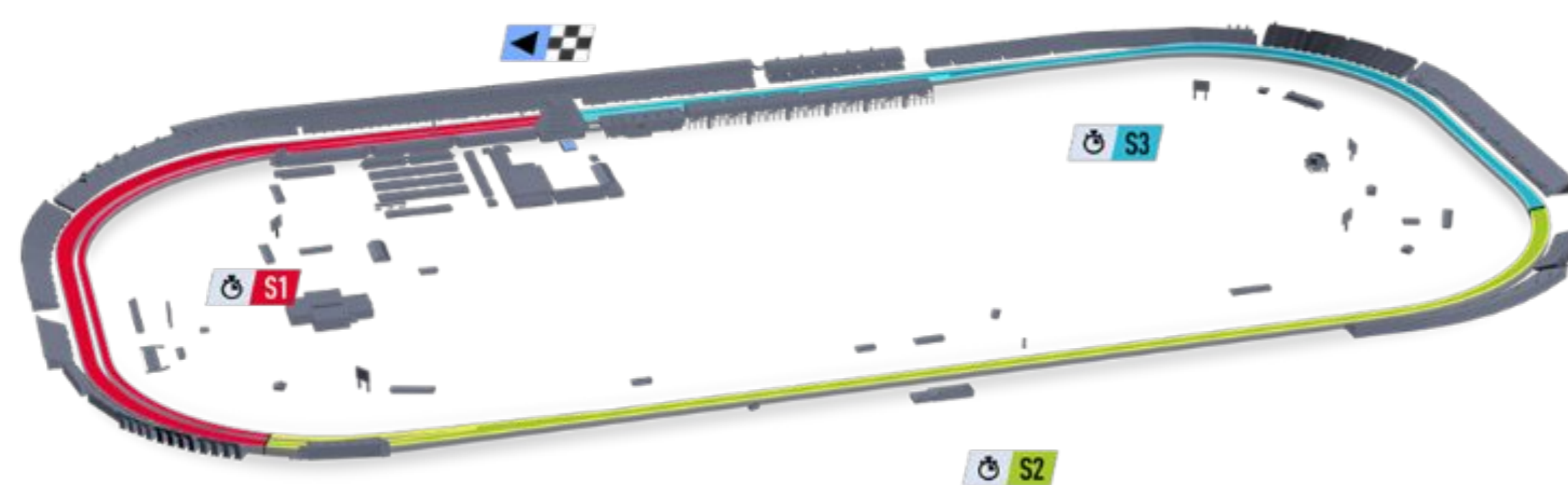
Cybersickness (motion sickness in virtual environments) has been an impediment to the widespread adoption of head-mounted display (HMD) technologies. One approach to mitigate cybersickness in HMDs has been the use of redirected tilting, that is, eliciting head tilt towards the direction of rotation, especially when turning a corner (Nie & Suma Rosenberg, 2021). This approach relies on the postural-instability theory of motion sickness (Ricchio & Stoffregen, 1991). However, there is a lack of research examining actual head tilt in virtual environments, and whether actual tilt bears any relation to cybersickness. The aim of my project is to examine this relationship so as to inform the design of future cybersickness mitigation techniques. I aim to address this issue in the context of other factors that have documented relevance to cybersickness, including the existence of postural precursors of cybersickness (e.g., Munafo et al., 2017), and sex differences in cybersickness susceptibility (e.g., Koslucher et al., 2015; Munafo et al.). Previous studies have not asked whether postural precursors of motion sickness might exist in actively controlled head tilt.

## Methods

- Sample was made up of 36 participants with equal numbers of men and women (18 each).
- Participants drove a virtual vehicle presented via a head-mounted display (Oculus Rift).
- We used an "off the shelf" driving simulation game (*Project Cars 2*) featuring a driving circuit with numerous turns. Our methods are based on recent research (Munafo et al., 2017; Curry, Li et al., 2020; Curry Peterson et al., 2020).
- After the Informed Consent process, participants sat on a stool and were fitted with the Oculus headset, which also carries motion sensors.
- Participants drive a simulator race car (using a steering wheel and pedals) around the circuit at their own speed for up to 15 minutes.
- During driving, we collected data on head and torso motion in 6 degrees of freedom.
- Following completion of the 15-minute exposure, motion sickness incidence and severity was assessed using the *Simulator Sickness Questionnaire*, a standard, validated measure (Kennedy et al., 1993).
- We separately assessed the incidence of motion sickness, the severity of symptoms, and angular head tilt, using techniques from previous studies (Munafo et al., Curry, Peterson et al., 2020).

## Results

We found higher cybersickness incidence among female participants than male. There was no significant effect of condition on the mean direction in which people tilted while immersed. However, tilt was greater across time while immersed. This means that as time immersed increased, so did the amount people tilted.



## Discussion

We found higher incidence of cybersickness among women, and the existence of postural precursor of motion sickness in linear measures of head movement. In documenting actual head tilt in a driving simulator and by evaluating the hypothesis that head tilt reveals novel postural precursor of motion sickness, these results provide empirical grounding for the development of redirected tilting as a method of cybersickness mitigation.



## References

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