

# Cybersickness Symptom Profiles in Long-Duration Immersive AR

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# WELCOME



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# Problem & Importance

- Over past several years, vast improvements in augmented reality (AR) technology have been made, yet many people still report experiencing cybersickness symptoms from their use
  - >50% of participants are expected to experience at least some degree of discomfort upon initial exposure
  - Adverse physiological effects are expected to be compounded when an AR headset is donned for extended periods of time
- If AR technology poses substantial adverse symptoms, this could limit mass adoption and present safety concerns
  - Critically important to assess adverse physiological impact of AR exposure

# Methods

- Adults aged 19-55 years ( $M = 25.45$ ,  $SD = 7.36$ ) of both genders
- Device
  - HoloLens  $n = 24$
  - Magic Leap  $n = 24$
- Exposure
  - 3- 40 min sessions with 30 min breaks
  - 6- 20 min sessions with 30 min breaks
- Post Exposure Measurement
  - 0 min, 15 min, 30 min, 45 min, 60 min
- Dependent Measure
  - Simulator Sickness Questionnaire (SSQ; Kennedy et al., 1993)

*Does augmented reality (AR) have important negative effects on physiological state and does this negatively impact user experience and post exposure safety?*



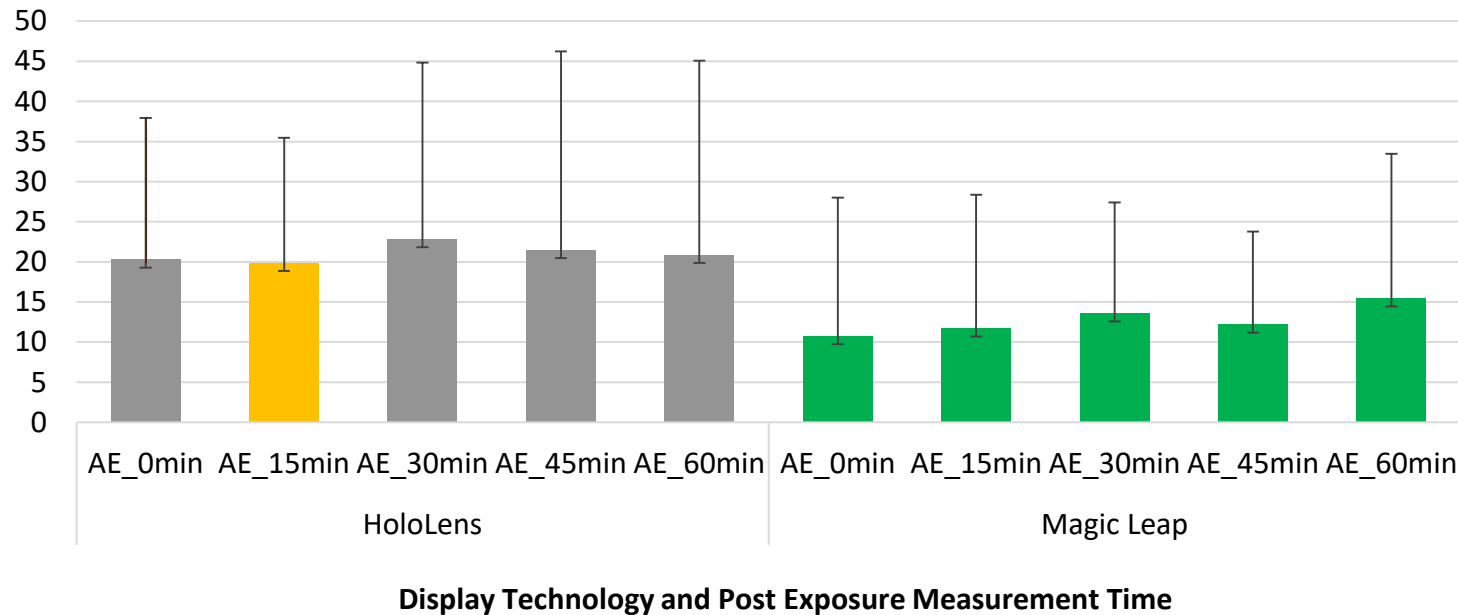
**Magic Leap**



**HoloLens**

# Results

Total SSQ Mean Scores



## AR Stimulus “Dose”

Low, 25<sup>th</sup> percentile (<15.5)

Moderate, 50<sup>th</sup> percentile (>15.5 to 20.1)

Medium, 75<sup>th</sup> percentile (>20.1 to 27.9)

High, 95<sup>th</sup> percentile (>27.9 to 33.3)

Extreme, 99<sup>th</sup> percentile (>33.3 to 53.1)

Based on VR Total SSQ Scores (Stanney et al., 2014)

*HoloLens exposure is presenting with overall discomfort in 75<sup>th</sup> percentile, on average of VR system scales, but reaches as high as the “extreme” 99<sup>th</sup> percentile*

# Symptom Profile O>D>N

SSQ Profile for 3- 40 min Exposure Protocol

Display Type	HoloLens		Magic Leap	
	M	SD	M	SD
SSQ Oculomotor (O) Subscore	*25.21	1.33	15.35	3.03
SSQ Disorientation (D) Subscore	15.68	1.52	9.74	1.56
SSQ Nausea (N) Subscore	11.25	1.65	6.44	1.99

\*p<0.05 HoloLens greater than Magic Leap

- Both HoloLens and Magic Leap present with an *O>D>N* symptom profile, with predominantly oculomotor disturbances
- HoloLens *O* symptoms are significantly higher than Magic Leap
- HoloLens use is expected to be associated with experience of eyestrain, difficulty focusing, blurred vision, and headache at *moderate to extreme levels*



# Initial Design Guidelines



To enhance safety, may need to limit exposure duration in immersive HWD AR systems to 20 min, with at least 30 min breaks between exposures until personalized, real-time assessment of adverse physiological effects is widely available.



For immersive HWD AR exposure longer than 20 min, expect higher levels of adverse effects, such as prolonged headaches and eyestrain post exposure, which should be measured for their severity.



Until adaptive AR-based training solutions are adopted, which personalize training experience based on trainee proficiency and physiological well-being, consider adopting a dual technology usage protocol, where AR tablet-based training delivers declarative knowledge of longer duration and immersive AR headset-based training is used to deliver shorter duration, fully contextualized, and embodied training experiences focused on procedural and conditional (strategic) knowledge.

# QUESTIONS?

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# Cybersickness Symptom Profiles in Long-Duration Immersive AR **THANK YOU!**

