

Virtual Reality

Review on Cybersickness in Applications and Visual Displays

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RENDERING MODE CYBERSICKNESS PUBLICATIONS

<i>Author</i>	<i>Stereoscopic / Monoscopic / Bi-ocular</i>	<i>Duration in minutes (Participants)</i>	<i>Item of Examination</i>	<i>Results</i>
(Rebenitsch 2015)	Monoscopic and Bi-ocular	24 (22)	Display Mode Effects	Stereoscopic rendering affects the likelihood of becoming cybersick, but not how severe
(Wibirama and Hamamoto 2014)	Stereoscopic	5 (20)	Eye Vergence and Accommodation	Fixing the gaze depth decreases cybersickness
(Vlad et al. 2013)	Stereoscopic	18 (102)	Eye Vergence and Accommodation	Focusing on the realism increases strain on the eyes as does focusing on the depth of an object in an image.
(Naqvi et al. 2013)	Stereoscopic and Monoscopic	10 (23)	Display Mode Effects	Stereoscopic movies has more symptoms than monoscopic movies
(Keshavarz and Hecht 2012)	Stereoscopic and Monoscopic	15 (79)	Display Mode Effects	Real stereoscopic video of a rollercoaster had higher cybersickness than a stereoscopic rendering of a 3D model of the rollercoaster or monoscopic versions
(Liu and Ung 2011)	Stereoscopic and Monoscopic	Less than 10 (60)	Display Mode Effects	HMD worse than regular monitor; 3D monitor near significantly worse than regular monitor; No difference between 3D monitor and HMD
(Yang and Sheedy 2011)	Stereoscopic and Monoscopic	90 (21)	Eye Vergence and Accommodation	Vergence and accommodation were farther from ideal in stereoscopic setting than monoscopic conditions
(Keshavarz et al. 2011)	Monoscopic and Bi-ocular	18 (51,39,20)	Display Mode Effects	No difference between monoscopic and bi-ocular
(van Emmerik et al. 2011)	Monoscopic	50 (40, 22)	Field of View	Decrease in postural stability, increase in symptoms with congruent external and internal fields of view
(Moss and Muth 2011)	Monoscopic	12 (80)	Field of View and Display	No peripheral vision increases symptoms

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(Bos <i>et al.</i> 2010)	Monoscopic	50 (20)	Field of View	Increase of external field of view and difference between internal and external fields of view have statistically significant effect on symptoms
(Toet <i>et al.</i> 2008)	Monoscopic	50 (20)	Field of View	Congruent fields of view increased symptoms more than incongruent
(Oyamada <i>et al.</i> 2007)	Stereoscopic	5 (7)	Physiological	Varied according to viewed stimulus
(Harvey and Howarth 2007)	Monoscopic	15 (18)	Field of View and Physiological	Symptoms increased with screen size and people got sick sooner; skin temperature rose, but it was not significant
(Hale and Stanney 2006)	Stereoscopic	60 (46)	Stereoscopic Ability Effects	No difference in symptoms with stereoscopic disparity
(Hakkinen <i>et al.</i> 2002)	Bi-ocular and Stereoscopic	60 (60)	Display Mode Effects	Postural sway and symptoms higher for HMD stereoscopic game than HMD movie or normal movie; the difference lasted for 30 after the stimulus; susceptibility had no statistical significance
(Lin <i>et al.</i> 2002)	Stereoscopic	2 each trial (10)	Field of View	Symptoms increased with field of view
(Seay <i>et al.</i> 2002)	Stereoscopic and Monoscopic	Not specified (156)	Field of View, Control, and Display Mode	Larger field of view increased nausea; interaction between testable items limits the implication of the results; nothing conclusive on monoscopic versus stereo
(Duh <i>et al.</i> 2001c)	Monoscopic	Not specified (10)	Field of View	Increasing FOV increased symptoms
(Draper <i>et al.</i> 2001a)	Monoscopic	30 (11) for FOV and (10) for lag	Field of View	Decrease in symptoms with correct external and internal fields of view ratio
(Stanney <i>et al.</i> 1999)	Stereoscopic	30 (34)	Space Discernment Detection	Significant shift error for vertical pointing location but not horizontal

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(Kolasinski and Gilson 1998)	Stereoscopic	20 (40)	Interpupillary Distance and Duration of Effects	14/40 had long terms (over an hour) symptoms; correlation between IPD and eyestrain
(Mon-Williams <i>et al.</i> 1998)	Not specified	Not specified(6)	Eye Heterophoria	Heterophoria varies with eye angle; on average the small error was at 34° below ear-eye line
(Mon-Williams and Wann 1998)	Stereoscopic and Bi-ocular (overlap not specified)	10 (28)	Eye Heterophoria	No difference among bi-ocular, small range stereo, and voluntary focus stereo; increases in illness symptoms, visual acuity and distance heterophoria for stereoscopic with continuous focus
(Ehrlich 1997)	Stereoscopic and Bi-ocular	Until completion (36)	Display Mode Effects	SSQ-N was higher for stereoscopic than bi-ocular
(Mon-Williams <i>et al.</i> 1995)	Stereoscopic and Bi-ocular	10 (20)	Eye Heterophoria	Stereoscopic displays had all but one had increases in heterophoria after 10m; bi-ocular displays had little effect after 30m