

Virtual Reality

Review on Cybersickness in Applications and Visual Displays

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CYBERSICKNESS DETECTION METHODS PUBLICATIONS

<i>Author</i>	<i>Duration in minutes (Participants)</i>	<i>Detection Method</i>	<i>Results</i>
(Chardonnet et al. 2015)	presumably around 10 (17)	Postural	Area, length, left-right length, forwards-backwards length, slope, and speed variance increase in variance increases with symptoms
(Bos et al. 2013)	74 (19)	Postural	Increase in standard deviation for both lateral and for-aft direction with a low-pass filter of 0.1HZ
(Chang et al. 2013)	10 (12)	Physiological	Delta and theta EEG power increase with cybersickness stimuli while alpha and beta decrease
(Bruck and Watters 2011)	NA(18)	Questionnaire	The SSQ and anxiety questionnaires have four main factor groups
(Keshavarz and Hecht 2011)	16-19 (126)	Questionnaire	A verbal one-point scale of 0-20 one feelings of sickness is well correlated to the SSQ-T and the SSQ-N
(Dong and Stoffregen 2010)	40 (26)	Postural and Control	Passengers sicker than drivers; drivers moved side-to-side more than passengers for head and torso; for-aft movement varied more for passengers than drivers
(Villard et al. 2008)	4, 10 min. each, 2 min. breaks (12)	Postural and Real vs. Virtual	Incidence and severity of symptoms in virtual room nearly identical to actual room
(Watanabe and Ujike 2008)	10 (18)	Navigation and Physiological	Disorientation increases with vertical navigation; no significant effect on total SSQ; correlation with heart rate ratio and duration
(Bouchard et al. 2007)	Varies (371)	Questionnaire	Redesigned SSQ to have 2 subcategories
(Harvey and Howarth 2007)	15 (18)	Physiological	VE exposure causes postural instability; women had greater changes in stability over time
(Kiryu et al. 2007b)	10 (15)	Physiological	LF/HF (blood pressure and respiration) increased with exposure time

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(Oyamada <i>et al.</i> 2007)	5 (7)	Physiological	Averaged LF/HF gradually increased with respect to the elapsed time; duration increased symptoms
(Smart <i>et al.</i> 2007)	Varied	Postural	Varied according to viewed stimulus
(Young <i>et al.</i> 2007)	30 (30)	Questionnaire	In the moving room 23% became ill, in the simulator 43% became ill, in the projector system, 17% became ill, and 42% percent became ill in a HMD
(Roberts and Gallimore 2005)	60 (10)	Physiological	Increase in tachyastria power during exposure
(Kim <i>et al.</i> 2004)	9.5 (61)	Physiological	Found correlation with gastric tachyarrhythmia, eye blink rate, respiration rate, respiratory sinus arrhythmia, and heart period
(Hakkinen <i>et al.</i> 2002)	60 (60)	Postural	Postural sway and symptoms higher for HMD 3D game than HMD or normal movie; difference lasted for 30 after the stimulus
(Cobb 1999)	20 (40)	Postural	Static and dynamic posture tests not statistically significant
(Stanney <i>et al.</i> 1999)	30 (34)	Space Judgment	Significant shift error for vertical pointing location
(Golding 1998)	NA(147)	Questionnaire	Simplified the Motion Sickness Susceptibility Questionnaire
(Kennedy <i>et al.</i> 1993)	NA (NA)	Questionnaire	Developed the Simulator Sickness Questionnaire