

SIMULATOR SICKNESS QUESTIONNAIRE: TWENTY YEARS LATER

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Simulator Sickness

- Symptoms are similar to motion sickness
- Cause:
 - Discrepancy between visual and vestibular systems



Assessing Simulator Sickness

- Simulator Sickness Questionnaire (SSQ) – Kennedy, Lane, Berbaum, & Lilienthal, 1993
- Goals:
 - A. to provide a more valid index of overall *simulator* sickness severity as distinguished from *motion* sickness;
 - B. to provide subscale scores that are more diagnostic of the locus of simulator sickness in a particular simulator for which overall severity was shown to be a problem; and
 - C. to provide a scoring approach to make monitoring and cumulative tracking relatively straightforward

SSQ

- Score 16 symptoms on scale of 0-3
- Symptoms are grouped by category
 - Oculomotor, Disorientation, and Nausea
- Weights are assigned based on category
- Scores are summed to create a single score

Revisiting the SSQ

- Vast changes in simulators/simulator technologies since 1993
- What is the relationship between the original flight sim data and driving simulators?
- Is there a relationship between SSQ symptoms/scores and participant dropout?
- Can we predict participant dropout?

Method

- Archival SSQ data
- FHWA Highway Driving Simulator
 - 240 FOV
 - 3 DOF motion base
- 9 different studies (2003-2012)

Method

- Participants – started with 995
 - Only healthy participants
 - Only the last SSQ scores were used in analysis
 - Excluded those with “0” for all scores
 - Excluded “boredom” dropouts
 - Excluded high scoring “stick-it-out” participants
 - Post exclusion criteria, 530 participants remained

SSQ Scores by Study

<i>Study</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Dropout %</i>
1	62	15.68	12.79	3.74	56.10	17.74
2	52	16.47	12.15	3.74	48.62	7.69
3	50	17.58	14.46	3.74	63.58	8.00
4	14	27.25	18.41	7.48	78.54	71.43
5	40	21.32	12.34	3.74	41.14	12.50
6	79	8.62	5.33	3.74	29.92	0.00
7	155	21.84	19.12	3.74	97.24	23.23
8	20	12.72	8.5	3.74	29.92	0.00
9	58	17.28	20.55	3.74	134.64	3.45

Results – Factor Analysis

- Exploratory factor analysis
 - Using the original Kennedy et al. criteria

Results - Factor Analysis

Symptom	Nausea		Oculomotor		Disorientation	
	2013	1993	2013	1993	2013	1993
Nausea	.74 *	.75 *	.10	.08	.09	.30 *
General discomfort	.64 *	.65 *	.22	.40 *	.06	.18
Stomach awareness	.48 *	.64 *	-.03	.03	.27	.21
Sweating	.40 *	.31 *	.06	.24	.04	.08
Increased salivation	.32 *	.53 *	.01	.21	-.11	.13
Vertigo	.31 *	.18	.29	.08	.27	.37 *
Burping	.18	.41 *	-.05	.04	.10	.22
Difficulty concentrating	.17	.32 *	.57 *	.39 *	.18	.27
Difficulty focusing	.05	-.01	.51 *	.61 *	.09	.43 *
Eyestrain	-.17	.00	.37 *	.74 *	-.02	.17
Fatigue	-.03	.15	.29	.54 *	-.13	-.04
Headache	.11	.22	.28	.53 *	.00	.15
Blurred vision	-.11	.01	.12	.36 *	.18	.40 *
Dizzy (eyes open)	.07	.17	.01	.07	.58 *	.76 *
Dizzy (eyes closed)	.17	.17	.00	.09	.58 *	.65 *
Fullness of head	.13	.12	.28	.17	.20	.37 *

Results – Dropouts & SSQ

	Mean	Median	SD	Min	Max
Dropout	39.63	33.66	21.52	11.22	134.64
Complete	14.00	11.22	11.33	3.74	52.36

Results – Dropouts & Symptoms

Symptom	Correlation
Nausea	0.7088***
General Discomfort	0.6515***
Stomach Awareness	0.3475***
Sweating	0.3315***
Increased Salivation	0.2043***
Difficulty Concentrating	0.1927***
Vertigo	0.1793***
Burping	0.1414***
Dizziness with Eyes Open	0.1116**
Fullness of Head	0.0998*
Dizziness with Eyes Closed	0.0860*
Difficulty Focusing	0.0962*
Headache	0.0727
Blurred Vision	-0.0024
Fatigue	-0.0458
Eye Strain	-0.0590

Results – Multiple Logistic Regression

$$\begin{aligned} \text{logit}[\pi(\mathbf{x})] &= \log \left[\frac{\pi(\mathbf{x})}{1 - \pi(\mathbf{x})} \right] \\ &= -4.63 + 1.48x_N + 1.10x_G + 1.06x_D + 1.02x_S + 0.91x_B + 0.86x_C \end{aligned}$$

- nausea (N),
- general discomfort (G),
- dizziness with eyes open (D),
- sweating (S),
- burping (B), and
- difficulty concentrating (C)

Results – Multiple Logistic Regression

$$\begin{aligned} \text{logit}[\pi(\mathbf{x})] &= \log \left[\frac{\pi(\mathbf{x})}{1 - \pi(\mathbf{x})} \right] \\ &= -4.63 + 1.48x_N + 1.10x_G + 1.06x_D + 1.02x_S + 0.91x_B + 0.86x_C \end{aligned}$$

- At .20 cutoff...
 - Model accounts for 29.22% of the variance
 - False positive (predicting a dropout where the participant completes the study) rate is 47.3%
 - False negative (predicting study completion, when a participant actually drops out) rate is 3.3%

Results – Study Factors

- Visual & vestibular incongruence = 😞
 - Curves
 - Turns
 - Stops
 - Especially without recovery
 - (Rapid) Speed changes
- Time/Length of drive

Discussion

- Kennedy et al.'s flight simulator sickness symptoms translate to more modern driving simulators
- The factor analyses are similar

Discussion

- Individual symptoms
 - May be more informative than the SSQ summary score
 - Especially nausea & nausea related symptoms
- Predicting dropouts
 - Using the logit model, may be able to predict simulator sickness dropouts
- Right now...
 - Validating the model
- Other simulators?

MOTION SICKNESS BAG

(For use during moments of stomach upset)

If an upset stomach is anticipated, remove bag from this container and keep ready for use. Do not be embarrassed by this precaution as even veteran travelers are subject to occasional motion sickness.

Financial support for this work was provided by FHWA contract #DTFH61-08-C-00006