

Virtual reality induced side effects: exploration of participants' characteristics in severe cases of cybersickness

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Introduction

- Since 2001, the Cyberpsychology Lab of UQO has conducted many studies on the effectiveness of virtual reality (VR) exposure therapy and the factors contributing to the feeling of presence.
- More recently, the team has paid an increased interest to the impact of cybersickness on VR applications.

Goals of this study

1. To report on the incidence of cybersickness following immersions in VR.
2. To describe some characteristics of the few participants who suffered from severe symptoms.

Participants



- Out of 371 adults who completed the Simulator Sickness Questionnaire (Kennedy et al., 1993) after an immersion in VR, we selected the:
 - 18 most severe cases of cybersickness;
 - these participants were divided in two subgroups.
- All were selected after having completed a screening instrument in order to exclude people susceptible to motion sickness or suffering from migraine.

Participants

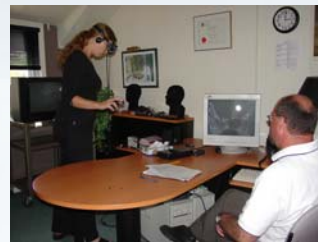
- Group 1 (n=3):
 - Our most extreme cases of cybersickness
 - Reported significant adverse event such as vomiting or reporting symptoms more than 48 hours after the immersion.
- Group 2 (n=15):
 - participants who scored above two standard deviations from the mean on the SSQ:
 - Group 2 was compared to 15 matched participants who scored “zero” on the SSQ following a virtual immersion.

Note: participant in Group 1 are not included in Group 2 and all analyses were conducted separately.

Hardware & Software

- **Hardware technologies:**

- Personal computers;
- HMDs;
- 3 DoF trackers ;
- Forward motion with a joystick.




Navigation required

- **Software used:**

- No navigation in VR:
 - VirtuallyBetter – Fear of flying;
- With navigation in VR:
 - *Modified 3D games:*
 - *Half Life™,*
 - *Unreal Tournament™*
 - *Max Payne™.*



No Navigation



Measures

- Demographic data: age, gender;
- Standardized questionnaires *:
 - Simulator Sickness Questionnaire
 - (Kennedy & al., 1993).
 - State-Trait Anxiety Inventory: Trait scale
 - (Spielberger, 1983).
 - Immersive Tendencies Questionnaire
 - (Witmer & Singer, 1998)
 - Presence Questionnaire
 - (Witmer & Singer, 1998)

* French validated versions were used

Results for Group 1 (3 extreme cases, out of 371)

- Case 1 and Case 3 (musophobia):
 - 2 x 5 minutes immersions (not for Rx);
 - Few movements required to navigate;
 - For both, symptoms started at the end of a 2nd immersion.
- Case 2 (acrophobia):
 - 3 x 20 minutes sessions (Rx with *in virtuo* exposure);
 - Navigation required to move to high places;
 - Symptoms started after 10 minutes of the 2nd immersion.

Results for Group 1 (3 extreme cases, out of 371)

	Case 1	Case 2	Case 3	Mean (s.d.)
Age	38	57	24	39.67 (16.56)
Gender	Male	Female	Female	2F:1M
Phobia	Mice	Heights	Mice	All phobics
Most severe symptoms	Stomach awareness Nausea Dizziness Salivation	Nausea Dizziness Discomfort Flashbacks Burping	Vomiting Nausea Discomfort Salivation Sweating	Mostly nausea and related symptoms
SSQ (Post)				
Total	112.20	74.80	71.06	87.27 (21.91)
Nausea	114.48	85.86	114.48	108.12 (11.02)
Oculor-Motor	68.22	30.32	30.32	42.95 (21.88)
Disorientation	125.28	97.44	41.96	88.22 (42.41)

Results for Group 1 Follow-up (> 24 hours post immersion)

	Case 1	Case 2	Case 3
Duration of symptoms	"4-5 days"	"2 days"	"2 hours"
Most severe symptoms	Discomfort Eyestrain Blurred vision Stomach awareness	Nausea Dizziness	Mild Discomfort
Phone screening	21/2 year later: reported intermittent symptoms that lasted approx. 6 months	6 years later: reported that symptoms lasted approx. 48h	24h later: No symptoms after vomiting (after immersion)

Results for Group 1 (3 extreme cases, out of 371)

- All participants are phobics and scored more severe symptoms on the nausea subscale than the oculomotor and disorientation subscales of the SSQ;
- At the follow-up (24 hours after the immersion), two of the three participants still had severe symptoms of cybersickness.

Results for Group 2 (15 highest SSQ scores out of 371)

Descriptive statistics and Simulator Sickness Questionnaire (SSQ) scores comparison between High-SSQ and Low-SSQ ("0") participants

	Group 2 Mean (s.d.) (n=15)		Group with no symptoms (n=15)
Age	42.47 (11.31)		46.47 (9.83)
Gender	86.7% Female		73.3% Female
SSQ:	(Min-Max)		
Total	82.28-145.86	101.01 (19.61)	0
Nausea	38.16-133.56	81.39 (33.02)	0
Oculor-Motor	45.48-106.12	78.83 (17.61)	0
Desorientation	69.60-208.80	56.14 (62.63)	0

Note: Mean score on the SSQ of 371 participants are: Total= 25.26 (28.02); Nausea =18.42 (25.17); Oculo-Motor = 23.17 (22.66); Disorientation = 24.59 (36.27).

Results for Group 2

(15 highest SSQ scores out of 371)

Results of univariate ANOVA analyses between High-SSQ and Low-SSQ participants on the STAI-Trait and the ITQ .

Questionnaires	Group 2 (n=15)	Group with no symptoms (n=15)	ANOVAs F(1,28)
STAI (Y2-Trait)	39.14 (10.60)	36.93 (9.74)	0.25 (0.62 n.s.)
ITQ:			
- Total	68.93 (11.27)	66.13 (13.91)	0.37 (0.55 n.s.)
- Focus	24.53 (4.60)	25.60 (4.78)	0.39 (0.54 n.s.)
- Implication	15.73 (6.20)	15.60 (6.63)	0.003 (0.96 n.s.)
- Emotion	17.40 (4.9)	14.13 (4.66)	3.49 (0.07 n.s.)
- Game	6.00 (3.30)	5.07 (2.52)	0.75 (0.39 n.s.)

Note. ANOVA = analysis of variance. STAI: State-Trait Anxiety Inventory (Y2 - Trait); ITQ: Immersive Tendencies Questionnaire; SSQ = Simulator Sickness Questionnaire.

Results for Group 2

(15 highest SSQ scores out of 371)

Results of univariate ANOVA analyses between High-SSQ and Low-SSQ participants on the Presence Questionnaire.

Questionnaires	Group 2 (n=15)	Group with no symptoms (n=15)	ANOVAs F(1,28)
PQ:			
- Total	89.93 (14.44)	87.73 (20.29)	0.11 (0.74 n.s.)
- Realism	33.93 (8.51)	26.13 (10.86)	4.58 (0.04*)
- Afford to Act	17.57 (5.02)	20.73 (4.56)	3.16 (0.09 n.s.)
- Interface qual.	15.40 (2.85)	15.93 (3.90)	0.18 (0.67 n.s.)
- Afford to Examine	14.07 (3.91)	14.53 (3.80)	0.10 (0.75 n.s.)
- Performance	9.27 (2.52)	10.40 (3.11)	1.20 (0.28 n.s.)
- Auditory	15.53 (3.62)	14.07 (5.48)	0.75 (0.40 n.s.)
- Haptic	5.67 (3.66)	6.73 (3.63)	0.64 (0.43 n.s.)

Note. ANOVA = analysis of variance. PQ = Presence Questionnaire; SSQ = Simulator Sickness Questionnaire. * $p < .05$.

Results for Group 2

(15 highest SSQ scores out of 371)

Comparison on the type of specific phobia between the High-SSQ and Low-SSQ participants.

	Group 2 (n=15)	Group with no symptoms (n=15)	
Age	42.47 (11.31)	46.47 (9.83)	n.s.
Gender	86.7% Female	73.3% Female	n.s.
Type of phobia:			
- Acrophobia*	2	3	
- Claustrophobia*	6	1	
- Arachnophobia*	5	2	
- Aviophobia	2	5	
- Musophobia	0	2	
- Non-phobics*	0	2	

* These virtual environments require to navigate often during the immersion.

Results for Group 2

(15 highest SSQ scores out of 371)

Results of univariate ANOVA analyses between Level of navigation on the Presence Questionnaire.

Questionnaires	Navigation (n=15)	No Navigation (n=15)	ANOVAs F(1,28)
PQ:			
- Total	86.80 (15.74)	93.22 (21.05)	0.84 (0.37 n.s.)
- Realism	29.30 (10.93)	31.22 (9.63)	0.21 (0.65 n.s.)
- Afford to Act	19.00 (3.95)	19.67 (7.00)	0.11 (0.75 n.s.)
- Interface qual.	14.76 (3.30)	17.78 (2.59)	5.91 (0.02*)
- Afford to Examine	14.65 (3.86)	13.56 (3.75)	0.51 (0.48 n.s.)
- Performance	9.33 (2.76)	11.00 (2.83)	2.26 (0.14 n.s.)
- Auditory	14.86 (3.81)	14.67 (6.42)	0.01 (0.92 n.s.)
- Haptic	6.14 (3.69)	6.33 (3.67)	0.02 (0.90 n.s.)

Note. ANOVA = analysis of variance. PQ = Presence Questionnaire. * $p < .05$.

Results for Group 2

(15 highest SSQ scores out of 371)

Results of Chi-squared analyses between the level of navigation High/Low SSQ participants.

	High or low SSQ Scores		TOTAL
	Low	High	
Navigation	8	13	21
No Navigation	7	2	9
TOTAL	15	15	30

Chi-squared	Value	Significance
	3.97	0.05*

Note. SSQ = Simulator Sickness Questionnaire. * $p < .05$.

Results for Group 2

(15 highest SSQ scores out of 371)

- All participants with high scores on the SSQ were phobics and mostly females;
- Severe symptoms varied between participants and SSQ subscales;
- The ANOVAS showed:
 - Users with high scores on SSQ found the virtual environment more realistic than the other group;
 - Users who had to move more (navigate) in the VE scored higher on the interface quality subscale of the PQ;
 - No difference was found on on age, gender, STAI, ITQ of PQ (Total).
- The Chi-squared showed:
 - High-SSQ participants were mostly immersed in virtual environments that require more navigation (e.g., as opposed to VB's fear of flying software).

Discussion

- ⊖ Cybersickness is understudied and poorly understood in clinical samples.
- ⊖ These results suggest that phobics and women may be more prone to cybersickness.
- ⊖ Increased navigation in the virtual environment seems to induce more cybersickness.
- ⊖ SSQ seem to be useful to assess cybersickness symptoms, but it doesn't differentiate symptoms which clearly interfere with people functioning (e.g. vomiting, vertigo, dizziness, nausea, etc.) from those who do not interfere as much (e.g. fatigue, difficulty focusing, sweating, etc.).
- ⊖ There is no useful information that can guide clinicians in predicting who will experience severe cybersickness.