Revising the factor structure of the Simulator Sickness Questionnaire

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Introduction

- Cybersickness, or more precisely virtual reality induced side effects, represents a variety of unwanted symptoms caused by an immersion in a virtual environment.
- Cybersickness does happen, at least in some specific settings (e.g., training, experimental research).
- However, data based on clinical sample is more scarce.

Side effects of VR

- Some basic incidence data (Lawson et al., 2002):
  - almost 60% of people on first immersion report some Sx,
  - 5% report significant Sx.
  - 35% report no Sx at all.
- Wilson (1997; VIRART), N = 233, HMD, immersions from 20 to 120 min.
  - 80% has some symptoms, 5% had to stop.
- Not dangerous in “healthy” subjects.
- Rarely a problem in FoF, maybe more prevalent in the treatment of other mental disorders. But still…
Simulator sickness

• First documented by Havron and Butler (1957) and Reason (1969).
  
  ■ Motion sickness (motion maladaptation syndrome)

  \[
  \begin{align*}
  &\quad \text{Simulator sickness} \\
  &\quad \text{Virtual Reality-induced symptoms and effects.}
  \end{align*}
  \]

• Sopite Syndrome (Graybiel & Knepton, 1976)
  – Drowsiness, difficulty concentration, apathy

Some limitations of incidence studies

• Studies on cybersickness revealed that symptoms depend on several factors:
  – technology used (CAVE vs HMD, FoV, etc.);
  – speed and accuracy of the hardware;
  – the task performed by the user;
  – individual differences.

• How does these studies, often based on military personnel using flight simulators, relate to our clinical populations?
These limitations also apply to the measurement of cybersickness

- There are few instruments available:
  - Motion Sickness Questionnaire
  - Simulator Sickness Questionnaire
    - Kenedy, Lane, Berbaum & Lilienthal, 1993
      * developed with Navy simulators
  - Virtual Reality Symptom Questionnaire

Typical symptoms

<table>
<thead>
<tr>
<th>SSQ subscales</th>
<th>Discomfort</th>
<th>Fatigue</th>
<th>Headache</th>
<th>Eyestrain</th>
<th>Diffic. Focusing</th>
<th>Salivation</th>
<th>Sweating</th>
<th>Nausea</th>
<th>Dizzy</th>
<th>Vertigo</th>
<th>Etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>N, O</td>
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Aim

• Assess the factor structure of the SSQ with a sample of people drawn from the general population, including people suffering from anxiety disorders.

Method

• 371 adults (71% female) recruited in the general population either for research on anxiety disorder
  – (n = 164 DSM-IV diagnoses based on the SCID)
  – specific phobia, social phobia, generalized anxiety disorder, panic disorder with agoraphobia and post-traumatic stress disorder.
• or experiments with “normal controls”
  – (n = 207 screened with the SCID for the absence of anxiety disorders).
• Mean age 35.2 (s.d. = 12.96, range from 18 to 68).
Material

- In order to maximize the generalization of the results, participants were immersed in virtual reality with different technologies (HMD, CAVE-like), different HDM (I-Glass, Cy-Visor, nVis, V8, Visette-pro), different trackers (Intertrax2, Inertia CUBE, IS-900), and performed different tasks (i.e., exposure to feared stimuli, exploration, attention) and for different durations (immersions lasted between 5 to 60 minutes).

Results

- Analyses conducted separately with anxious and non-anxious people yielded similar results. Data were therefore collapsed for the final analyses.
- A principal factor analysis was performed, followed by a varimax rotation. The number of factors was assessed based on three criteria: eigenvalue higher than one, the scree-plot test and the interpretability of the factor solution (including reducing cross-loadings to a minimum). The eigenvalue criteria pointed towards a three-factorial solution but between two to four factors were examined.
- Only the two-factor solution was satisfactory.
A confirmatory factor analyses (SEM)

- The two factor model provided an adequate fit to the data, as shown with a variety of fit indexes:
  - $\chi^2$ (99, N = 141) = 280, $p < 0.01$
  - CFI = 0.91, NFI = 0.66, GFI = 0.92
  - RMSEA = 0.07, RMR = 0.02
  - and examination of the modification indexes.
- A comparison between the two and three factors model confirmed that the two-factor model was more parcimonious:
  - AIC = 354 vs 369, respectively
  - BIC = 498 vs 536, respectively

Table 2. Factor structure of the French SSQ in the current sample. N = 371.

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor 1 (Nausea)</th>
<th>Factor 2 (Oculomotor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General discomfort</td>
<td>.70</td>
<td></td>
</tr>
<tr>
<td>2. Fatigue</td>
<td>.44</td>
<td></td>
</tr>
<tr>
<td>3. Headache</td>
<td>.56</td>
<td></td>
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<tr>
<td>4. Eye strain</td>
<td>.72</td>
<td></td>
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<tr>
<td>5. Difficulty focusing</td>
<td>.76</td>
<td></td>
</tr>
<tr>
<td>6. Increased salivation</td>
<td>.54</td>
<td></td>
</tr>
<tr>
<td>7. Sweating</td>
<td>.61</td>
<td></td>
</tr>
<tr>
<td>8. Nausea</td>
<td>.67</td>
<td></td>
</tr>
<tr>
<td>9. Difficulty concentrating</td>
<td>.51</td>
<td></td>
</tr>
<tr>
<td>10. Fullness of head</td>
<td>.66</td>
<td></td>
</tr>
<tr>
<td>11. Blurred vision</td>
<td></td>
<td>.79</td>
</tr>
<tr>
<td>12. Dizzy (eyes open)</td>
<td>.52</td>
<td></td>
</tr>
<tr>
<td>13. Dizzy (eyes closed)</td>
<td>.63</td>
<td></td>
</tr>
<tr>
<td>14. Vertigo</td>
<td>.62</td>
<td></td>
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<tr>
<td>15. Stomach awareness</td>
<td>.69</td>
<td></td>
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<tr>
<td>16. Burping</td>
<td>.48</td>
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</table>

Note: Factor loadings lower than .40 are not reported.
Discussion

- The SSQ may have two factors in clinical samples.
  - Differences in population…
  - Differences in tasks…
  - Differences in hardware / software…
- It needs replication.
- The oculomotor Sx may relate more to the technology used to display the image and the nausea factor to the effect of postural imbalance.
- The overlap with anxiety Sx must be documented.