Cybersickness and anxiety during simulated motion: Implications for VRET

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Abstract. Some clinicians have suggested using virtual reality environments to deliver psychological interventions to treat anxiety disorders. However, given a significant body of work on cybersickness symptoms which may arise in virtual environments – especially those involving simulated motion – we tested (a) whether being exposed to a virtual reality environment alone causes anxiety to increase, and (b) whether exposure to simulated motion in a virtual reality environment increases anxiety. Using a repeated measures design, we used Kim’s Anxiety Scale questionnaire to compare baseline anxiety, anxiety after virtual environment exposure, and anxiety after simulated motion. While there was no significant effect on anxiety for being in a virtual environment with no simulated motion, the introduction of simulated motion caused anxiety to increase significantly, but not to a severe or extreme level. The implications of this work for virtual reality exposure therapy (VRET) are discussed.

Keywords. Anxiety, virtual reality exposure therapy

Introduction

Anxiety disorders represent a very significant proportion of disorders treated by clinical psychologists worldwide. Psychologists have worked to develop new interventions based on emerging technologies such as the Virtual Reality Environment (VRE). Two studies into virtual reality exposure therapy (VRET) reported improvements in efficacy of VRE as compared to control programs using in vivo cognitive behavioral treatment (CBT) [1] and imaginal exposure therapy [2]. In addition, two extensive meta-analysis studies [3,4] confirmed these findings.

While VRET holds great promise, there is a concern that the use of VREs may in themselves contribute to the anxiety reported by experimental participants and that this may interfere with the efficacy of the VRET for anxiety disorders. Kim [5] reported a significant correlation between anxiety and cybersickness in VREs in healthy participants. In contrast, in a study into patients diagnosed with persecutory delusions, researchers found that VREs did not result in increased anxiety responses [6].

In a study which assessed the neuroendocrine response to stress evoked by a VRE as compared to a control group, Kelly [7] reported that participants exposed to virtual
environments recorded lower salivary cortisol levels than those who were required to deliver a speech to a virtual audience, suggesting that the exposure to the VRE was not the factor that increased the cortisol level.

Considering that VRE therapy is becoming more accessible for the treatment of a range of anxiety disorders [8] including fear of flying (aviophobia) [2], panic disorder and fear of open spaces (agoraphobia) [1], we are concerned that VRET may cause an increase in anxiety, thereby defeating the purpose of the clinical intervention.

Since many cybersickness symptoms are associated with simulated motion [5], we wanted to test whether being in a VRE alone would increase anxiety, or whether the presence of simulated motion was necessary. If VRET interventions for anxiety could be delivered with no (or low) simulated motion, then this would alleviate concerns about anxiety increases occurring during therapy.

We hypothesized that there would be no anxiety reported (a) during immersion in the VRE, and (b) during use of a VRE with low simulated motion. Furthermore, we hypothesized that anxiety would increase when simulated motion was introduced, compared to a baseline.

1. Method

A within-subjects design was used to compare self-reported anxiety measures from a pre-treatment baseline (a single frame image), to a control condition (VRE with low simulated motion), and from the control condition to an experimental condition (VRE with high simulated motion). Participants acted as their own controls. Participants completed Kim’s Anxiety Scale questionnaire [5] prior to immersion in the VRE after the control condition, and also after the experimental condition. Twenty eight (18 male, 10 female) Macquarie University students aged 18 – 30 years volunteered to participate. Participants were healthy, with normal or corrected to normal vision. Written informed consent was obtained. This experiment was approved by the Macquarie University Human Ethics Committee. The VRE consisted of a setup with a 160° field of parabola curved projection canvas, with 3 color projectors, and Liquid Crystal Display synchronized shutter glasses (Figure 1). The pre-control condition showed participants a photograph of a snow covered landscape for three minutes. In the control condition, the participant travelled slowly over snow covered hills. The experimental condition was a virtual rollercoaster. Both the control and experimental simulations lasted for two minutes, and ran three circuits of the environment, making a 6 minute journey.
2. Results

Table 1 shows the Anxiety Scale [5] results. The hypotheses were tested using paired sample \( t \)-tests. The \( t \)-tests were performed to examine the difference between the anxiety response to VRE in a Pre-Control (no simulated motion), Control (low simulated motion) and Post-Control (high simulated motion) conditions.

The prediction that there would be no significant difference between the Pre-Control anxiety and the Control anxiety scores was supported, \( t(27)=-1, p=0.326 \).

In contrast, there was a significant difference between the mean anxiety score of the Post-Control and the Post-Experimental mean anxiety score \( t(27)=-3.382, p=0.002 \). The results indicate that the introduction of simulated motion caused significant increases in anxiety for the participants.
### Table 1. t-test results from the Anxiety Scale.

<table>
<thead>
<tr>
<th>Pre/Post VRE Experiment</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Control and Control</td>
<td>-0.071</td>
<td>0.378</td>
<td>0.326</td>
</tr>
<tr>
<td>Control and Post-Control</td>
<td>-0.714</td>
<td>1.117</td>
<td>0.002 *</td>
</tr>
</tbody>
</table>

* Significant p<0.05

3. Discussion

The main propose of this study was to explore whether VRET reported results are being compromised by the inherent effects of the VRE. Our investigation looked at whether the VRE was creating an anxiety response with our experimental participants. The results confirmed the prediction that participants do not report an increase in stress when they are immersed in a VRE. Our findings corroborate the results reported by Kelly [7] that it is not the virtual environment that is stressful, but what is performed or perceived by the participant in the VRE that is creating the stress response.

Furthermore, our research into whether exposure to simulated motion in a VRE causes an increase in anxiety, demonstrated that perceived motion in a VRE is sufficient to create mild anxiety as reported using the Kim Anxiety Scale [5]. Our analyses support the results reported by Kim [5] that navigation through a virtual environment can provoke an anxiety response. The results from this study infer that the effectiveness of VRET for treating anxiety disorders may be impacted where there is simulated motion.

Demonstrating that healthy participants do not find immersion in a VRE anxiety provoking appears to confirm the meta-analyses reports that VRE do not generate anxiety responses [3,4]. The main difference, between the meta-analysis studies and the Kim [5] and current study is that these two studies tested healthy young adults in comparison to the meta-analyses studies that exclusively assessed participants with a range of clinically diagnosed anxiety disorders, including Post Traumatic Stress Disorder, acrophobia, aviophobia and arachnophobia.

We need to be cautious about comparing the studies that test people with diagnosed anxiety disorders [1,2,3,4,8] with studies of healthy participants. Further research needs to be carried out to investigate whether healthy individuals’ results can be projected to treatment options for individuals with specific clinically diagnosed anxiety disorders. Clients with an anxiety disorder are possibly responding to the VRE in a different way to healthy experimental participants. Future studies into anxiety responses in virtual environments will need to be conducted to determine whether specific anxiety responses are to be expected for particular anxiety diagnoses.

Baseline anxiety responses for standardized VREs need to be determined for healthy individuals. Once these are available, further work is required to clarify baseline readings for specific diagnoses such as phobias and other anxiety conditions.
Definitions of what is a normal response for a healthy population as compared to a particular diagnosis will provide the opportunity for a therapeutic tool that would also be accessible for people with specialized accessibility needs.

VREs are an emerging therapeutic tool in the treatment of anxiety disorders. Our results imply that VREs will have a role in CBT. VREs are relatively easily adjustable to meet the therapeutic stage of treatment. They can be less costly and often safer to use than in vivo treatments for the management of aviophobia or acrophobia.

In a therapeutic situation, where there is significant simulated motion in the VRET used for treating anxiety disorders, clients’ responses to the treatment may be affected. It is possible, that the impact of the simulated motion may interfere with the clients’ anxiety response. VRET may only be appropriate for certain types of anxiety disorder CBT procedures.

4. Conclusions

Virtual reality environments may be a useful tool for VRET in specific therapeutic cases. We conclude that immersion in a VRE is not in itself stressful. For this reason its use in CBT may be valid. Our results, however, show that once the VRE involves simulated motion, healthy adults report an increase in anxiety. With careful development of the VRE to avoid or limit simulated motion, VRET may become a valuable remedial instrument that can be targeted for graduated exposure therapy in a safe and reproducible setting.

References


