The Effect of a Projected Virtual Reality Training Environment on Vision Symptoms in Undergraduates

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Introduction

The Directorate of Medical Imaging and Radiotherapy at the University of Liverpool recently received funding from the UK Department of Health to introduce the use of a Virtual Environment for Radiotherapy Training (VERT). The VERT (see Figure 1) provides students with an immersive experience of a simulated clinical situation (a simulated clinical linear accelerator), within which they are able to alter treatment parameters, position a virtual patient for radiotherapy delivery and see the resulting distributions of radiation dose. However, virtual reality (VR) systems commonly induce unwelcome symptoms (collectively known as “cybersickness”) in a proportion of the population (Shaples et al. 2008). Most attention has focused on head-mounted VR systems; relatively little is known about the effects of projected systems on large numbers of subjects. Therefore we investigated whether visual symptoms were induced by the Liverpool VERT in a group of undergraduate Radiotherapy students undergoing training.

Methods

The VERT comprises a 3D stereoscopic dual-projector back projection system and a 2.4 x 5.3 m screen (Figure 1). Active stereo goggles worn by users automatically switch between stereo projector views to simulate a 3D environment.

With local ethical committee approval, two groups of first-year Radiotherapy students from the University of Liverpool participated in this study. All participants provided written consent. Group 1 (n=33; mean age 22y) had a full orthoptic investigation and refraction, prior to their first exposure to the VERT. This included measurement of habitual visual acuity for near and distance, cover test for near and distance, prism fusion range for near and distance, stereopsis for near (using TMS), ocular motility, AC/A ratio and convergence. Group 1 completed a symptom questionnaire before and after VERT exposure on two occasions approximately 4 weeks apart. Group 2 (n=30; mean age 23y) completed pre- and post-exposure symptom questionnaires for a single session. Students were exposed to the VERT in groups of 4 or 5; sessions lasted approximately 60 minutes.

In order to examine the occurrence and severity of the symptoms induced in our subjects, we used the Virtual Reality Symptom Questionnaire (VRSQ; Ames et al. 2005). This was initially designed to investigate the effects of head-mounted VR displays and comprises two lists of symptoms (General and Eye) relevant to viewing in VR environments. A scoring system from 0 (None) to 6 (Severe) is provided for each symptom (Figure 2).

Results

The mean distance and near acuities in Group 1 were 0.05±0.18 and 0.01±0.15 respectively (LogMAR, mean±SD, see Figure 3); median stereopsis was 45’ of arc with 28 out of 32 subjects (87.5%) having 60’ of arc or better. Four subjects had either gross stereopsis or suppression due to one anisometropic amblyopia, uncorrected refractive error, childhood astigmatism and congenital cataract surgery in one eye. While these subjects did not benefit from the VR environment they did not experience significant symptoms either. Combining data from Groups 1 and 2 (Session 1 only), suggested small, but statistically significant rises in symptom scores (shown by rises in both General and Eye sub-scores) as a result of VERT exposure (Figure 4). This rise was observed in both groups as well as in the combined data. From Group 1 were analyzed in more detail. Firstly, the pre-exposure scores from Sessions 1 and 2 were compared (Figure 5). There were statistically significant differences between the two sessions for both Total and General symptom scores, with the session difference in Eye symptom score failing to reach statistical significance. Given these differences, in order to compare the effect of VERT exposure between sessions we calculated the difference between Post-session and Pre-session scores for each Session for each subject (Post - Pre; an increase in symptom score is indicated by a positive difference). While there were no statistically significant differences between sessions (Figure 6), there did appear to be a trend, with a larger increase in symptoms less prominent in the second session (i.e. as many negative as positive difference scores in Session 2). For the Group 1 Session 1 data, we examined the relationships between the results of the vision tests and the symptom scores. None were statistically significant with the exception of Distance Prism Fusion Amplitude (PPA, Figure 7). We found a statistically significant negative correlation between PPA and both the Total and component scores. Thus subjects with larger PPA tended to have lower symptom scores.

Discussion

Large scale deployment of VR systems in education, raises the issue of the likelihood of these systems inducing visual symptoms in student cohorts. Using the VRSQ, we found that the Liverpool VERT system did not induce uncomfortable symptoms in a cohort of undergraduate Radiotherapy students. It did however produce measurable increases in symptom scores at least in the first session of exposure. In the second session this effect was not present. However, we also found that the baseline measurement (the pre-exposure scores) could differ statistically significantly between sessions. Thus perhaps only small effects of exposure are anticipated, the baseline state of participants must be measured. We found that in Group 1 there were a number of students (43%; 12%) who could not benefit from the VERT because they only had gross stereopsis or suppression. While this does not prevent VERT being used as a training tool, it would raise issues of equity if it were to be used for assessments. Among a number of measurements of visual function, the only correlation between functional measure and symptom score we found was with distance PPA.

It is possible that projected systems, in which participants are largely passive observers of a VR environment, are less likely to induce eye symptoms than head mounted systems which make higher demands on the visual system (Shaples et al. 2008). Our results are similar to those recently reported by Flinton and White (2009) for a similar system elsewhere in the UK.

References


Acknowledgements

This study was supported by a College of Radiographers Industrial Partnership Scheme Research Award.