

12 Hours in Virtual Reality: Two Cases of Long-Term Exposure to Consumer-Grade Virtual Reality

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ABSTRACT

In this paper we describe a study exposing two users to consumer-grade virtual reality (VR) for a total of 12 hours. The participants experienced a variety of different commercial VR applications and simulator sickness was measured once every hour for the duration of the study. Both participants experienced varying degrees of sickness throughout the 12 hours of exposure and reported increased sickness seven hours into the study.

Index Terms: I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual Reality;

1 INTRODUCTION

Recent advances in display and tracking technology have brought virtual reality (VR) out of the laboratory and into public, and a wide range of VR applications are available to consumers who can engage with VR content whenever they want and for as long as they want to. While the effects of long-term exposure to computer games have been widely investigated (e.g., [1, 2]), the same cannot be said for VR. To our knowledge, the only published work involving VR exposure exceeding three hours was performed by Steinicke and Bruder [5]. One of the two authors reports on his experience of being exposed to VR for 24 hours while wearing an Oculus Rift DK1 head-mounted display (HMD) displaying two experiences: a computer generated virtual living space and a virtual island. The user could freely transport himself from one environment to the other whenever he wished to do so. The experiment was divided into two hour blocks of exposure to VR, followed by 10 minutes breaks where the user could remove the HMD. In this paper, we present a similar user study that exposed two participants, with limited VR experience, to commercial VR applications for a total of 12 hours.

2 USER STUDY

The study was performed on the participants' own initiative and they defined the duration of the exposure. Specifically, the participants were journalists from the Danish Broadcasting Corporation producing episode about VR for the television show *Nørd* (Nerd) aimed at 7-12 year old children.

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2.1 Participants

The two participants were aged between 20 and 30 years. One participant was male and one female (henceforth participant 1 and 2). They were accompanied by two colleagues who documented the study and ensured that they would monitor the well-being of the participants for at least three hours after the study was concluded.

2.2 Setup and Procedure

As prolonged exposure to commercially available VR applications and hardware has yet to be studied, the VR content was displayed using two commercially available HMDs, namely an Oculus Rift CV1 and a HTC Vive. Both setups included two controllers. Relatively popular commercial VR applications belonging to a variety of different genres were used for the study (see Figure 1). The participants explicitly requested that we included applications likely to elicit a range of different emotions, including negatively valenced emotions, such as fear. After a briefing, the two participants donned the HMDs and were exposed to the first VR application. The participants were instructed to interact with each application for as long as they wished to. The participants constantly wore the HMDs for the whole 12 hours. However, they were asked to remove the HMDs after six hours when they alternated between the two HMDs. They were blindfolded as this was taking place. Moreover, they were instructed that they could ask to stop the experience at any point, or they could ask for a toilet break. Both participants requested a toilet break only once during the whole duration of the experiment. They were guided to the toilet while wearing the HMD by members of our lab. Regarding food and beverages, the participants were offered water and light refreshments (fruits and snacks) during the day, which they were eating while wearing the HMD. In the evening their colleagues provided them with a warm meal.

2.3 Measures

Like Steinicke and Bruder [5], we used the Kennedy-Lane Simulator Sickness Questionnaires (SSQ) [3]. The SSQ was administered 13 times during the study: once before the two participants donned the HMDs and once every hour during the 12 hours of exposure. The questionnaire was administered verbally and all items were explained to the participants before the session began. Moreover, we registered what application each participant was currently using.

3 RESULTS

Figure 1 shows results of the SSQ for the two participants over time. Specifically, the three sub-scales, nausea, oculomotor discomfort and disorientation, and the total score are visualized. The horizontal axis also shows the application the participants were using prior to the SSQ being administered, as well as what HMD they were currently using. It is interesting to note that both participants appear to have experienced a peak in simulator sickness after seven hours of exposure. When the peak was recorded both participants were using applications permitting physical locomotion and encouraging creative expression at the user's own pace, namely *Fantastic Contraption* (participant 1) and *Tilt Brush* (participant 2). Thus, it seems

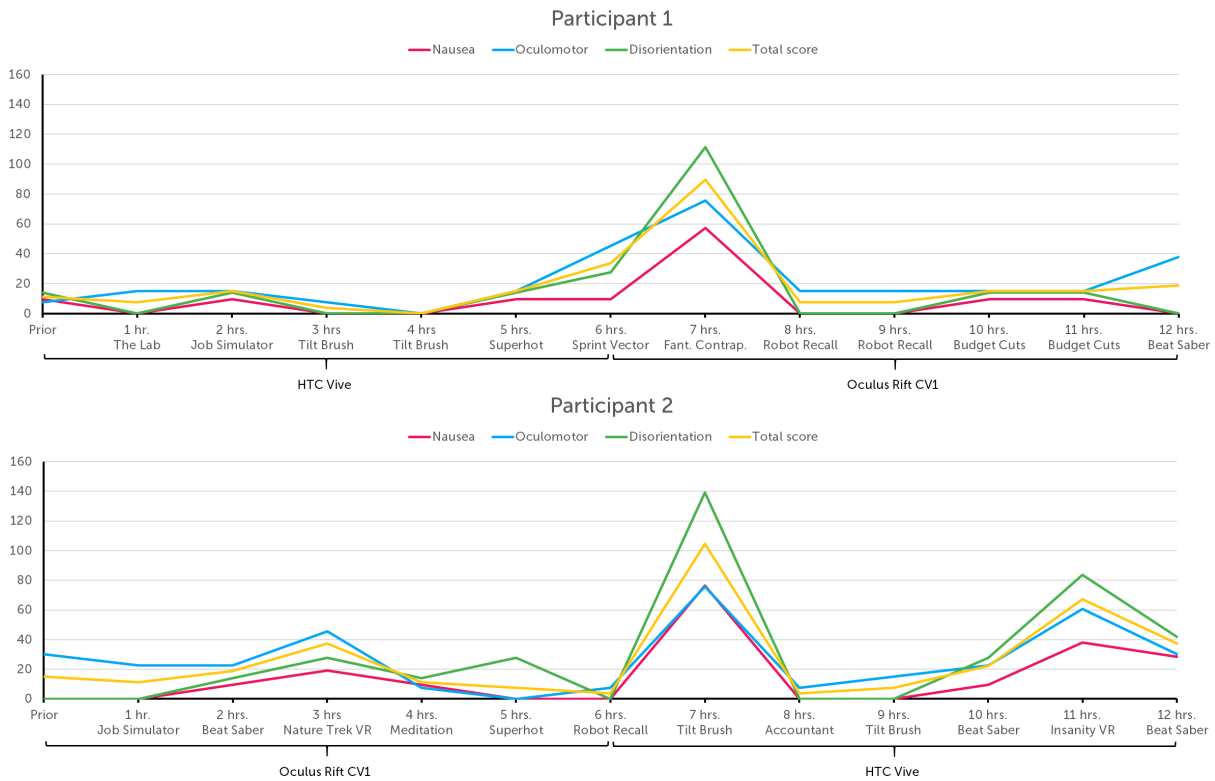


Figure 1: Results of the SSQ for the two participants across the 12 hours of exposure. Both charts show the three SSQ sub-scales (nausea, oculomotor, and disorientation) as well as the total score. The current application and VR device is shown below the x-axes.

possible that the specific applications are not to be blamed for the seeming increase in simulator sickness. Instead, it is worth noting that these measures were recorded approximately one hour after the two participants changed HMDs. This raises the question of whether acclimating to a different, albeit relatively similar, visual display caused the participants to experience increased simulator sickness. However, we cannot rule out that the peaks may have been caused by some external factor, because the setting was not fully controlled (e.g., two people documenting the study for the television show were present in the room).

It is also worth noting the peak in the scores of participant 2 occurring after 11 hours of exposure. It is possible to offer at least two explanations for this peak, which are not necessarily mutually exclusive. The specific application played by participant 2 involves virtual locomotion while the user remains stationary. As the associated visuo-vestibular conflict is likely to cause simulator sickness, the peak may be indicative of a genuine increase in sickness intensity. Nevertheless, it is worth questioning whether this peak is an indication of simulator sickness per se, or an indication that the symptoms forming the basis for the SSQ also accompany other experiences. Specifically, when the peak was recorded, participant 2 was playing *Insanity VR* – a horror experience likely to elicit negatively valenced affect which may be accompanied by sweating and nausea.

The mean total score was 18.4 (SD=22.1) and 28.9 (SD=28.4) for participant 1 and 2, respectively. Thus, participant 1 appears to have experienced considerably lower sickness than participant 2. However, it remains uncertain whether this difference is the result of differences in terms of their prior experience with VR (participant 1 reported having tried VR before while participant 2 did not) or if the variation can be attributed to gender differences, which previously have put forth as an individual difference affecting susceptibility to simulator sickness [4].

4 CONCLUSION

The two participants reported varying levels of simulator sickness throughout the 12 hours of exposure and a notable spike in scores was observed after seven hours. No continuous increase or decrease in scores over time is apparent, making it difficult to conclude whether any acclimatization occurred or if sickness increased over time. Besides from the spikes in scores, the reported scores indicated that the symptoms of simulator sickness were relatively mild, and they were not severe enough for participants to discontinue the experience. However, it should be emphasized that the participants were journalists, and so may have been professionally incentivized to remain immersed for the full duration.

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