

# Unwanted side effects of immersive virtual reality using head-mounted displays

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## STATEMENT OF THE PROBLEM

The gaming industry has always strived to bring its customers the most realistic and immersive experience available. One constantly developing branch of virtual reality solutions are head-mounted displays. All products, from the most primitive such as Virtual Boy for the NES (Nintendo Entertainment System) to the modern equivalent Oculus Rift, attempt to place the player directly in to the game world.

Users of these systems, however, have always struggled with unwanted side effects such as nausea and headaches [1]. This phenomenon is called cybersickness [1] [2] or simulator sickness [3]. Cybersickness has been known by the industry and the manufacturers ever since the first virtual reality products were launched. Not only were the products not very ergonomic, for example Virtual Boy was known to cause physiological discomfort as well [4]. Studies show that nausea can be caused lag in the display [2] and generally when high field-of-vision techniques are used to create realistic immersion [5]. For these reasons, cybersickness is self-evidently an issue makers of these devices want to minimize or get completely rid of.

This research focuses on the modern head-mounted displays to study the effects of cybersickness.

## RESEARCH QUESTIONS AND/OR HYPOTHESES

The development of virtual reality devices such as head-mounted displays has been rapid and modern products are getting closer to a state, where the technology itself is no longer a hindrance of the immersion experience. This research studies whether this aspect has led to a decrease in the effects of cybersickness.

This study shall also answer whether cybersickness is stronger for people who suffer also from motion sickness and if people experience cybersickness similarly or do some people react to virtual environments more aggressively than others.

It is assumed that people with motion sickness suffer more from cybersickness than people without the condition.

## METHODS AND PROCEDURES

The study will test the effects of cybersickness with Oculus Rift, a modern head-mounted display device. The experiment will be held at the University of Oulu one test user at a time. Test users will watch a video and play a game using Oculus Rift. Before and after the experiment, users shall fill out a simulator sickness questionnaire [3], which can be used to analyze the physiological state of the user. The questionnaire includes many symptoms such as general discomfort, fatigue, headache and eyestrain. Users are also prompted to write in if they suffer from motion sickness to see if the relationship between cybersickness and motion sickness exists.

### Variables

Test users will be using the same test device and will watch the same video and play the same game to generalize the test environment.

Users fill out the questionnaire also before the test to analyze their physiological well-being. When comparing the user-specific results before and after the test, it can be seen if physiological state before the test has an effect in the results.

Users will also be categorized into two groups: people with and without motion sickness. These groups will be evaluated separately to see if there is a difference between the groups.

Users shall do one half of the test sitting down and the other half standing up. The experiment for one user shall last 15 minutes.

### Sampling

Selected test users will be university students who are willing to participate in the experiment.

### Instrumentation

The main test device is Oculus Rift, a modern head-mounted display with high field-of-vision. Only one such device is used for this experiment, meaning only one test user can be evaluated at one time. The device is connected

to a computer, which is used to show a video and run a game. Users will be also wearing headphones for even better immersion in the virtual world.

Users will watch the tech demo Rift Coaster (<http://www.theriftlist.com/Home/Game?Name=Rift%20Coaster>) and play the game Rift Racer (<http://www.theriftlist.com/Home/Game?Name=Rift%20Racer>) with the device.

Users will fill out a simulator sickness questionnaire before and after the experiment.

#### **Data collection**

Data from the simulator sickness questionnaires are collected in Microsoft Excel and IBM SPSS.

Information about users' motion sickness is also logged in Microsoft Excel and IBM SPSS to enable grouping users.

#### **Data analysis**

Data is analyzed in Microsoft Excel and IBM SPSS. User specific physiological well-being is derived from the questionnaires and an increase factor is calculated from the results before and after the experiment. Users can be also grouped based on whether the user felt physically well or weak before the test. Overall increase in physical illness is also calculated. Differences between users with and without motion sickness are measured.

#### **LIMITATIONS AND DELIMITATIONS**

This study uses only one type of head-mounted display, Oculus Rift. Other devices might produce different results, but they are not included in the research due to lack of availability.

Users also evaluate their physical well-being only through subjective means and no objective checks, for example medical examinations, are done.

The scope of this study is narrowed down to modern technology in general. It would not be feasible in this study's context to acquire older products since they are very expensive and rare.

Test users are also limited to university students, who are mainly young adults aging from 18 to 30 years. For more comprehensive testing, a larger age group would be needed. Younger people might also be more accustomed to virtual reality devices and gaming in general, which could skew the results slightly. On the other hand, studies have shown that young people are more prone to the effects of cybersickness [1].

#### **SIGNIFICANCE**

The purpose of this research is to learn if modern head-mounted displays cause effects of cybersickness similarly as their predecessors do. There are currently no other studies testing the effects of cybersickness using Oculus Rift specifically. This study deepens the knowledge on cybersickness and handles the different kinds of symptoms separately. The results of this study could be very useful to the manufacturers of the devices, who try to eliminate these undesired side effects.

#### **REFERENCES**

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