

Preventing Virtual Reality Motion Sickness in College Students New to VR: Causes, Symptoms, and Solutions

Literature Review

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In summarizing the early studies of “virtual reality sickness,” as the authors term what is generally referred to throughout this literature review as virtual reality motion sickness, for consistency, Chang et al. describe how “symptoms were oftentimes speculated to originate from poor performance of the hardware, and it was thought that user’s discomfort would be reduced as VR technology matured” with advances like higher resolution and framerates, and wobulation, a 45° shift and alternation in pixel illumination relative to the array which reduces the ‘screen door effect’ of being able to see the small gaps between pixels or seeing projected geometries of multiple pixel arrays superimposed through each other.

However, as the authors point out, these advances have not contributed to a significant reduction in the rate of VR motion sickness in users while using VR headset devices, also known as head-mounted displays (HMDs), as of the time of writing (Chang et al.). In recent years, as HMDs have become more consumer available, the prices for better quality equipment has steadily decreased, and demand for devices has increased, there has been more and more focus in the industry on solving the problem of VR motion sickness.

Content-related causes are another primary concern with virtual reality motion sickness and have been studied in depth. Sensory mismatch between visual and vestibular systems when experiencing vection, the visual illusion of movement when actually stationary, has been identified as a primary cause. Roll motion and its effect have also been studied (Sumayli & Ye).

There are other content-related factors that influence a user’s physiological properties such as heart rate, blood pressure, and blood sugar level, like the difference between being in a pleasant or neutral VR environment and being in a horror setting with horror sequences such as jump scares (Chattha et al.). These aspects of the content can

prime the user to be more susceptible to stimuli or “sensory mismatches” (Laessoe et al.) that usually cause VR motion sickness.

In order to better understand the experienced phenomenon of VR motion sickness, many subjective measures of the experience have been constructed by researchers. In a survey by Chang et al. of 77 studies, all but one created at least one system of subjective measure of virtual reality, most deriving from the Simulator Sickness Questionnaire (SSQ), and almost half of the studies surveyed used multiple subjective measures, for a total of 117 subjective measurements from the 77 studies.

Kim et al. have made a more modern, updated Virtual Reality Sickness Questionnaire (VRSQ), as Simulator Sickness, the term referenced in SSQ, is becoming an outdated, and the SSQ overall as a measuring has begun to become outdated as well, they argue. This VRSQ questionnaire breaks VR motion sickness into and categorizes many different symptomatic subcomponents: “The oculomotor component consists of general discomfort [...], fatigue [...], eye strain [...], and difficulty in focusing [...]. The disorientation component consists of headache [...], fullness of head [...], blurred vision [...], dizziness with eyes open [...], dizziness with eyes closed [...], and vertigo [...],” an concerningly uncomfortable set of factors which highlights the urgency of needed solutions for VR motion sickness.

The prevalence of subjective measurements has more recently brought researchers to also parallelly consider objective measurements of VR motion sickness, with the goal of being able to record physiologically the data that is most correlated with user reports of symptoms. Of the 77 studies reviewed by Chang et al., with 42 studies collecting 72 different objective measurements, 9 studies of which collected more than one measurement, the most common form of measurement was postural sway, or the apparent loss of balance and the process of regaining it with small movements throughout the body, followed by changes in electrocardiogram (ECG) reading, measurements of the eyes, changes in electrogastrogram (EGG) reading, changes in electroencephalogram (EEG) reading, skin conductivity, breathing measurements, and other physiological data.

While there is general agreement that VR motion sickness is a physiological phenomenon worth studying, there is not unanimous consensus that the phenomenon is clinically divergent from typical, “classical” motion sickness, with some studies showing no significant difference between the (supposedly) two clinical entities (Mazloui et al.).

Research has also been done into possible correlation between VR motion sickness and sex of the user, with multiple results indicating that there may be a higher rate of occurrence in females than in males (Chattha et al., and Munafo et al.). These studies are fairly limited in their interpretation of sex and gender, but can be of some informative value in these still early stages of understanding the phenomenon.

Although most Extended Reality (XR, a blanket term for virtual reality (VR) and augmented reality (AR)) motion sickness research and experimentation has been concerned with VR, there have been studies into the AR experiences, such as those using AR glasses, which induce motion sickness (Yu et al.).

While there has been some direction for how to solve VR motion sickness using design techniques, i.e. “Our results, together with those of Koslucher et al. (2015, 2016a, b), suggest that solutions may be found by addressing aspects of design that influence users' ability to stabilize their own bodies” (Munafo et al.), the most common theme in the survey of the publications included in this literature review express that more research and experimentation into the subject is needed to more fully understand VR motion sickness:

“More experimental evidence is required for a better estimate of VR sickness” (Chang et al.).

“In literature, assumptions exist about the relationship of different physiological and subjective measures of motion sickness in virtual environments. However, no adequate empirical evidence exists to support this belief. Therefore, the lack of empirical investigation makes it difficult for researchers to state any relationship confidently” (Chattha et al.).

“Further discussion and experiments are needed to provide a deeper rationale for the elimination of nausea” (Kim et al.).

“In addition, adverse effects of VR may depend on individual characteristics and the character of sensory conflicts in VR exposure. Consequently, more research within this field is needed” (Laessoe et al.).

“It is both ironic and frustrating that "better" technology has been associated with more motion sickness” (Munafo et al.).

“Further investigation should consider the factors responsible for the variation in VR sickness to improve the VR experience during exposure to motion for all users” (Sumayli & Ye).

While the publication from Mazloumi et al. does not have as quotable of a segment about this need for further research, its entire “conclusion contradicts previously published results” regarding the clinical designation of the malady, which implies the notion that further research is needed in order to settle academic and nomenclatural disputes and to reach more standardized and uniform research approaches and practices in the field.

Therefore, the proposed study seeks to understand this problem by addressing the following research question: What are the predominant causes and symptoms of virtual reality motion sickness, and does one proposed solution prevent symptoms, reduce severity, or delay onset?

References

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