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Cybersickness during highly immersive virtual reality simulation for learning in healthcare

Síntomas durante el uso de simulación con realidad virtual altamente inmersiva para el aprendizaje en salud

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We read with great interest the article by González et al (1) supporting the use of highly immersive virtual reality (VR) simulation for anatomy learning. The results of their systematic review highlighted a positive reception of the VR experience by students, with an increase in enjoyment and attention, and at least the same effectiveness for learning when compared to traditional cadaveric methods. They also highlighted VR technology can become a long-term investment that reduces costs. These findings are in line with the results of other systematic reviews indicating that immersive VR for education was easy to use, facilitated learning of content (2), and increased cognitive and psychomotor performance (3).

Although the review by González et al. (1) reported that there were few adverse effects associated with using VR (such as headache, dizziness, nausea, etc.), this technology may trigger symptoms in users of the so-called cybersickness. Translational movement in an immersive VR environment using head-mounted displays (also known as locomotion) originates a mismatch between visual and vestibular information, causing ambiguity of the position of the body in relation to its surrounding. Vulnerable users might experience loss of balance, vertigo, nausea, headache, sweating or numbing of the hands, trembling, disorientation or a "weird feeling" that can cause severe discomfort and might limit its use (4).

As VR technologies are becoming increasingly useful in multiple domains, such as training, research, rehabilitation, or surgical planning we think it is helpful to be able to anticipate the percentage of participants that may be affected. In the case of educators, this will allow them to have alternative educational activities available, so mental workload and learning outcomes of susceptible participants are not compromised.

In our institution, seventy-three postgraduate first-year residents and ten preceptors (N = 83) took part in an immersive VR-based serious game for team training during nine courses. Participants had to assess and manage a patient with an allergic reaction. They were on vacation at an aquatic hotel resort in separate cabins, where they had to find different resources to treat and evacuate the patient. They played in groups of four during 15 min and had to focus on communication, role clarity, common objectives, and shared goals. The game was designed in our institution and was supported by the Innova Program of the Cantabrian Government and the European Union to promote technological innovation in healthcare. Four residents and two preceptors (7.2%) refused to participate due to past experiences of claustrophobia (n = 2) or imbalance (n = 4). Four residents and three preceptors (9.1%) self-reported motion sickness in less than 5 minutes from the start, and they recovered shortly after taking the head-mounted displays off. One remained nauseated for more than two hours. It is noteworthy that 15.7% of the total number of participants could not complete the activity, although they were able to use the desktop

version of the game without experiencing cybersickness. A traditional group activity was kept ready in case the technology failed, but it was not necessary to use it in any edition.

Other studies indicated that cybersickness was much more pervasive, with 35% of the participants experiencing it. Some show 65.2% of incidence and 23.9% severe symptoms. The most commonly used subjective methods to measure cybersickness during the VR experience are the Fast Motion Sickness Scale and the Simulator Sickness Questionnaire. It is more difficult to apply objective methods to detect biological signals, such as an electrocardiogram, electrooculography, electrodermal activity, breathing, or cortisol levels (5).

Several studies have tried to identify individual characteristics to detect cybersickness vulnerability. Participants with a self-reported tendency to motion sickness were relatively more affected, while physiological measures may not be a reliable standalone method to detect or predict it in real-time. Black participants reported considerably less cybersickness than white participants. Moreover, although no individual balance characteristics could be associated, caution in high-fall-risk populations is recommended (Laessoe et al., 2023).

Developers are studying the best design and selection of locomotion methods to minimize the impact. Engineers are pushing to reduce lag differences between head movements and motion on the display, as it increases the severity of cybersickness. Some manufacturers recommend intermittent breaks to overcome these symptoms, although research results are contradictory. Cybersickness appears to be much more severe in the watching mode, compared to the playing mode. The simultaneous presentation of sound and motion seem to be effective in reducing symptoms. Previous studies have suggested that pleasant music, odor, and taste can mitigate symptomatology, showing the complex and potentially bidirectional relationship with emotions, but the mechanism remains unclear. Artificial Intelligence software designed may reduce cybersickness (6).

We believe that it is important to continue to investigate the incidence and management of cybersickness to facilitate the use of highly immersive VR simulation for healthcare education.

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Referencias

1. González T, Ibeas C, Gravent I, León A, Rojas M. Characteristics of a Virtual Reality scenario for anatomy learning: A literature review. *Revista Española de Educación Médica*, *2022*, 3: 81-92; http://doi.org/10.6018/edumed.542861
2. Mäkinen H, Haavisto E, Havola S, Koivisto JM. Graduating nursing students' user experiences of the immersive virtual reality simulation in learning – A qualitative descriptive study. *Nursing Open*, *2023*, 10, 3210-3219. https://doi.org/10.1002/nop2.1571
3. Choi J, Thompson CE, Choi J, Waddill CB, Choi, S. Effectiveness of Immersive Virtual Reality in Nursing Education: Systematic Review. *Nurse Education*, *2022, 47*, E57-E61. https://doi.org/10.1097/NNE.0000000000001117
4. Laessoe U, Abrahamsen S, Zepernick S, Raunsbaek A, Stensen C. Motion sickness and cybersickness - Sensory mismatch. *Physiology & Behavior*, *2023, 258*, 114015. https://doi.org/10.1016/j.physbeh.2022.114015

5. Garrido LE, Frías-Hiciano M, Moreno-Jiménez M, Cruz G N, García-Batista ZE, Guerra-Peña K, Medrano LA. Focusing on cybersickness: pervasiveness, latent trajectories, susceptibility, and effects on the virtual reality experience. *Virtual reality, 2022, 26*, 1347–1371. https://doi.org/10.1007/s10055-022-00636-4
6. Prinz LM, Mathew T, Weyers B. (2022). A Systematic Literature Review of Virtual Reality Locomotion Taxonomies. *IEEE transactions on visualization and computer graphics, 2022,* 1-17. https://doi.org/10.1109/TVCG.2022.3206915