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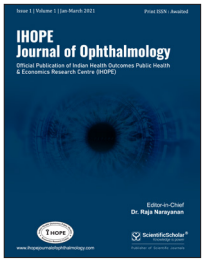

Letter to Editor

Vision therapy for future adolescents: Virtual and augmented reality

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Received: 10 June 2024
Accepted: 23 August 2024
Epub Ahead of Print: 24 December 2024
Published: 31 December 2024

DOI
10.25259/IHOPEJO_9_2024

Quick Response Code:

Dear Editor,

Virtual reality (VR) and augmented reality (AR) technologies create an immersive and interactive environment that can be particularly effective in vision therapy.[1] VR immerses users in a fully digital environment, simulating real or imagined scenarios, while AR overlays digital content onto the real-world view, enhancing perception and interaction with the environment.[2] For adolescents who are highly receptive to digital media, these tools can transform traditional therapy into engaging, customizable experiences. This engagement is crucial for increasing adherence to therapy regimens and improving therapeutic outcomes.[3]

ROLE IN REHABILITATION AND TRAINING

In the context of rehabilitation, VR and AR have shown promise in treating conditions such as amblyopia and strabismus.[4,5] VR headsets, for instance, can present unique visual stimuli to each eye, thereby promoting neural adaptation and visual acuity.[6] AR can overlay therapeutic exercises onto real-world scenarios, seamlessly integrating vision training into everyday life and making the rehabilitation process more practical and continuous.[7,8]

ROLE IN DIAGNOSTICS

These technologies can simulate comprehensive visual field tests and other diagnostic procedures, providing detailed assessments of a patient's vision.[9] Furthermore, the ability to monitor eye movements and visual processing in real time enhances the accuracy and depth of diagnostic evaluations, leading to better-informed treatment plans.[10]

ADVANTAGE OF ACCESSIBILITY

One of the most transformative aspects of VR and AR in vision therapy is their potential to deliver remote treatment. Adolescents in underserved or remote areas can access high-quality vision therapy through VR and AR platforms, reducing the need for frequent clinical visits.[11-13] VR and AR accessibility in remote areas is facilitated by internet-connected devices such as VR headsets and AR-enabled smartphones or tablets. These tools enable adolescents to participate in vision

therapy sessions at home, offering tailored exercises and assessments for conditions such as amblyopia and strabismus. Users download specialized VR or AR applications designed for vision therapy, guiding them through structured exercises and evaluations. Internet connectivity supports remote monitoring by healthcare providers, ensuring effective therapy progression.[14] It democratizes access to essential eye care, ensuring timely and effective treatment for a broader population, resonating with the concept of Universal Health Coverage.

REVIEWING PRIOR STUDIES

In recent studies, both VR and AR platforms have shown significant improvements in treating amblyopia. A study with 145 amblyopic children demonstrated that VR and AR training significantly enhanced best-corrected visual acuity (BCVA) ($P < 0.001$) and fine stereopsis ($P < 0.05$). The AR group notably improved contrast sensitivity function across all frequencies ($P < 0.05$), while the VR group showed specific improvements at spatial frequency 12 ($P = 0.008$). Similarly, dichoptic VR training in 17 adults with anisometropic amblyopia resulted in improved BCVA ($P < 0.01$) and stereoacuity ($P < 0.01$). These findings underscore VR and AR as promising treatments for amblyopia, warranting further clinical validation.[15,16] In addition, a study on adults with anisometropic amblyopia using a VR videogame showed sustained improvements in contrast sensitivity and stereopsis 1-month post-treatment, indicating potential long-term efficacy.[17]

LIMITATIONS AND CHALLENGES

Despite their potential, VR and AR technologies face several limitations and challenges. The high cost of VR and AR devices can be a significant barrier to widespread adoption, particularly in low-resource settings. In addition, concerns regarding the long-term use of these devices, such as potential eye strain or other adverse effects, require further investigation.[1] Ensuring user-friendly interfaces and maintaining patient engagement over time are critical challenges that must be addressed. Moreover, the effectiveness of these technologies in clinical practice needs validation through large-scale, rigorous clinical trials.

FUTURE DIRECTIONS AND RESEARCH NEEDS

While the current applications of VR and AR in ophthalmology are promising, ongoing research and development are essential to realize their potential fully. Collaborative efforts among ophthalmologists, technologists, and researchers are necessary to refine these technologies, develop standardized treatment protocols, and validate their efficacy through rigorous clinical trials.

CONCLUSION

The integration of VR and AR into vision therapy represents a significant advancement in the management of ophthalmic conditions in adolescents. These technologies not only enhance the effectiveness of treatments but also make vision therapy more accessible and engaging. The scientific community should continue exploring and investing in these innovative solutions to improve adolescent eye health.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent was not required as there are no patients in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that they have used artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript or image creations.

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How to cite this article: Minnu Lekshmi R, Nirupama AY. Vision therapy for future adolescents: Virtual and augmented reality. IHOPE J Ophthalmol. 2024;3:52-4.doi: 10.25259/IHOPEJO_9_2024