Leveraging Virtual Reality to Enhance Focus in Adults with ADHD: Exploring Non-Pharmacological Interventions

Mahya Tazike

Professor:

Andrew Miller, PhD

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Overview

Attention Deficit Hyperactivity Disorder (ADHD) significantly impacts individuals' cognitive and behavioral functioning, particularly in maintaining focus. This research explores the potential of Virtual Reality (VR) as an innovative intervention to enhance focus in young adults with ADHD. Leveraging immersive environments and gamified tasks, the study aims to evaluate the effectiveness and usability of VR-based tools in addressing ADHD-related challenges with focus. Employing a single-session pretest-posttest design, the research will assess changes in participants' focus levels and collect qualitative feedback on user experience. This study seeks to provide insights into VR's feasibility as a cost-effective and accessible alternative to traditional ADHD interventions by combining quantitative and qualitative data. The findings will contribute to advancing XR technologies in therapeutic contexts, with a focus on practical applications for ADHD management.

1. Introduction/Motivation

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder affecting around 7% of the global population, impacting both children and adults (Thomopoulos et al., 2019). The disorder is characterized by persistent patterns of inattention, hyperactivity, and impulsivity, which hinder academic performance, workplace productivity, and overall quality of life. Current treatment methods for ADHD, such as medication and cognitive-behavioral therapy, show effectiveness but come with limitations, including side effects, high costs, and limited accessibility. These factors underscore the need for innovative, accessible, and engaging treatment options, especially for addressing core symptoms like difficulty in maintaining focus (Karamian, 2023).

Extended Reality (XR) technologies, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), present promising non-pharmacological alternatives to manage ADHD symptoms (Cuber et al., 2024). For this research, we focus specifically on VR technology, known for its highly immersive nature, which can effectively capture and hold users' attention. VR's immersive environments offer a unique opportunity to help individuals with ADHD enhance focus by engaging them in controlled yet stimulating activities. Through features such as gamification, interactive feedback, and adaptive environments, VR may offer a personalized approach to improving focus in individuals with ADHD(Waterworth & Waterworth, 2001).

The theoretical basis for using VR in attention regulation lies in its ability to create immersive environments and leverage gamification elements to engage users. Immersion, a key feature of VR, reduces external distractions by fully capturing the user's sensory attention, thereby supporting sustained focus. Additionally, gamification mechanics, such as real-time feedback and rewards, can motivate individuals to persist in tasks while reinforcing attentional control. By combining these features, VR environments can provide structured and engaging experiences that directly address the focus challenges prevalent in

individuals with ADHD. This theoretical foundation underscores the potential of VR as a transformative tool for enhancing attention in ADHD populations.

This research aims to explore how VR-based interventions can be leveraged to specifically target and improve focus-related challenges in ADHD, with the goal of creating more sustainable and engaging alternatives to traditional treatments. By examining VR's potential to address the attentional needs of individuals with ADHD, this study aims to contribute new insights into non-invasive treatment options that complement or enhance current ADHD interventions.

2. Related work

2.1 ADHD Symptom Categories: Attention, Hyperactivity, and Impulsivity

Attention Problems

One of the primary challenges for individuals with ADHD is maintaining sustained attention. Difficulties in focusing on tasks, especially those perceived as monotonous or unengaging, are central to ADHD-related attention issues (Salmi et al., 2018). This proposal focuses specifically on addressing the *focus* problem within the realm of attention, leveraging VR technology. VR's immersive environments can create controlled, engaging tasks that help improve attentional control by minimizing external distractions and maintaining user engagement. By targeting focus enhancement through VR, this study aims to explore how immersive, tailored environments can effectively mitigate attention difficulties in ADHD.

Hyperactivity

Hyperactivity in ADHD is characterized by an excessive need for movement, restlessness, and difficulty remaining still (Kuntsi et al., 2014). This need for constant motion often disrupts daily activities and poses challenges in structured environments such as classrooms or workplaces. Hyperactivity not only impacts concentration but can also lead to increased frustration and difficulty completing tasks that require stillness or sustained focus (Colomer et al., 2017).

Impulsivity

Impulsivity in ADHD manifests as quick, unconsidered actions and difficulty in delaying responses (Toplak et al., 2009). This lack of impulse control affects decision-making and can lead to issues in social, educational, and professional settings. Impulsive behavior may cause individuals to interrupt others, act without considering consequences, and struggle with tasks requiring patience and reflection, which can strain personal relationships and hinder goal achievement (Stanton et al., 2018).

2.2 Traditional Treatment for Individuals with ADHD

Medication

One of the traditional treatments for ADHD is medication, which is commonly divided into two categories: stimulant medications and non-stimulant medications. Stimulant medications, such as Ritalin (methylphenidate) and Adderall (amphetamine salts), are the most frequently prescribed treatments for ADHD. These medications work by increasing levels of dopamine and norepinephrine in the brain, chemicals that are crucial for improving focus and reducing impulsivity and hyperactivity (Sheridan et al., 2010). Stimulants are particularly effective in managing ADHD symptoms in the short term, making them a popular choice for symptom control. However, they come with notable limitations. Common side effects include sleep disturbances, decreased appetite, and mood swings. Additionally, stimulants have a risk of dependency and are sometimes associated with misuse, especially among adolescents and adults (Thorell & Dahlström, 2009).

On the other hand, non-stimulant medications, such as Strattera (atomoxetine), provide an alternative treatment option. While they tend to have fewer side effects than stimulants, non-stimulants are generally considered to be less effective in managing ADHD symptoms (Himpel et al., 2005). These medications may be a better option for individuals who cannot tolerate stimulants or have comorbid conditions that

make stimulant use risky. However, like stimulants, access to both types of medication can be a barrier due to cost or limited availability in certain regions (Pedraza & Newcorn, 2015).

Therapy

Cognitive-behavioral therapy (CBT) is one of the most commonly used non-pharmacological interventions for adults with ADHD (Guo et al., 2022). CBT is a widely studied method for ADHD treatment, aiming to help individuals recognize and change thought patterns that lead to problematic behaviors. For adults, CBT addresses challenges such as time management, organization, impulsivity, and emotional regulation, which are often prominent in ADHD. Research has shown that CBT can improve attention, executive functioning, and behavior regulation, especially when combined with medication (Safren et al., 2005). However, this method is time-intensive, often requiring frequent sessions over extended periods, and can be costly or difficult to access, particularly in underserved areas (Safren et al., 2005).

Parent Training

Parent training programs are essential for helping parents manage the behaviors of children with ADHD. These programs teach parents how to implement behavioral strategies at home, such as reward systems, clear communication, and structured routines. Parent training has proven effective in reducing behavioral issues in children with ADHD, particularly in younger children(Zwi et al., 2011). The involvement of parents in treatment is critical, as it fosters consistency in managing ADHD symptoms across different environments, such as home and school. However, the success of these programs depends heavily on the parents' ability to implement the strategies effectively, and there are challenges in reaching families who may lack access to such resources(Kohut & Andrews, 2004).

2.3 XR and Individuals with ADHD

AR (Augmented Reality) and ADHD

AR technology is gaining attention as a potential tool for improving focus and attention in individuals with ADHD(Avila-Pesantez et al., 2018). AR integrates digital elements into the real-world environment, allowing users to interact with these elements in a way that enhances learning and engagement. For ADHD patients, AR can be used to create gamified tasks that capture attention and provide real-time feedback, thus encouraging sustained focus(Keshav et al., 2019). Studies have shown that AR can improve cognitive engagement by making tasks more interactive and visually stimulating, which is particularly beneficial for individuals with ADHD who often struggle with sustained attention(Tosto et al., 2021). However, the research on AR's role in ADHD treatment is still in its early stages, and more studies are needed to understand its long-term effectiveness. One limitation is that AR interventions may not be as immersive as VR, which could reduce their impact on symptom management over time.

VR (Virtual Reality) and ADHD

VR is one of the most explored XR technologies for ADHD treatment. VR creates immersive environments where individuals with ADHD can engage in attention-focused tasks without the distractions of the real world. In therapeutic settings, VR has been used to simulate controlled environments where patients can practice concentration, working memory, and impulse control(Romero-Ayuso et al., 2021). Research suggests that VR is particularly effective in helping children with ADHD practice sustained attention and reduce hyperactivity during tasks that require focus. Moreover, VR environments can be tailored to each patient’s needs, making the treatment more personalized. However, VR also has limitations(Pizzo et al., 2001. The equipment can be expensive, and prolonged use of VR can cause discomfort, such as motion sickness or eye strain. Additionally, like AR, more research is needed to determine VR’s long-term benefits for ADHD patients, especially when compared to traditional therapies(Corrigan et al., 2023).

MR (Mixed Reality) and ADHD

MR, which blends both the real and virtual worlds, is an emerging field in ADHD treatment(Goharinejad et al., 2022). Unlike AR or VR, MR allows users to interact with digital objects that are anchored in the real world, offering a hybrid experience that could be beneficial for ADHD treatment(Kim et al., 2020). Early-stage studies and pilot projects have explored how MR can be used to create interactive educational environments for children with ADHD, where real-world objects and virtual elements combine to provide a more engaging learning experience(Karamian, 2023). MR holds promise as a tool for cognitive and behavioral interventions, as it allows for more flexible and dynamic interactions than AR or VR alone(Goharinejad et al., 2022). However, MR technology is still under-researched, and there are significant gaps in the literature regarding its application in ADHD treatment. More studies are needed to evaluate the feasibility, accessibility, and long-term efficacy of MR for managing ADHD symptoms.

Traditional ADHD treatments, such as medication, therapy, and parent training, come with limitations like high costs, side effects, and the need for consistent, often labor-intensive involvement. Moreover, these methods may not fully engage individuals with ADHD, which can reduce their effectiveness over time. Virtual Reality (VR) technology, as a subset of Extended Reality (XR), offers a promising alternative by providing immersive and interactive environments specifically designed to capture and hold users' attention. While initial studies have shown XR's potential in ADHD treatment, VR's unique capacity to create deeply engaging and focused experiences remains underexplored, particularly for enhancing focus.

This research aims to fill these gaps by focusing on how VR can be leveraged to improve attentional control and enhance focus in individuals with ADHD. By examining the long-term effectiveness of VR-based interventions, this study will investigate VR's potential to supplement or replace traditional treatments and develop accessible, cost-effective solutions that specifically address the cognitive demands of individuals with ADHD.

3. Research Aims/Questions

Research Aim 1

To investigate the effectiveness of VR-based interventions in enhancing focus among young adults with ADHD.

Q1: How does VR immersion impact the focus duration and intensity in young adults with ADHD during task-oriented activities?

Q2: What role does gamification in VR play in maintaining and improving focus levels among this demographic?

Research Aim 2

To explore the usability and user experience of VR-based focus enhancement tools for young adults with ADHD.

Q1: What features of VR environments are most effective in maintaining user engagement and reducing distraction?

Q2: How do young adults with ADHD perceive the usability and accessibility of VR-based interventions designed to improve focus?

4. Research Methos/Approach

To assess the effectiveness of a VR-based intervention in enhancing focus among young adults with ADHD, this study will use a **single-group pretest-posttest design**. This approach will enable measurement of changes in focus before and after the VR intervention within the same participants, allowing for a straightforward evaluation of the intervention's impact.

Participants

The study will recruit young adults (ages 18-30) diagnosed with ADHD. Participants will undergo a focus assessment before and after engaging with the VR intervention to measure any changes in attentional capacity.

Procedure

- **Pretest Assessment**: Participants will complete a standardized focus assessment before engaging with the VR intervention. The assessment will include validated tools, such as continuous performance tasks (CPTs) and self-reported questionnaires (e.g., Adult ADHD Self-Report Scale), to establish baseline attentional capacity and focus duration.
- **VR Intervention Data Logs**: During the VR sessions, interaction data (e.g., time spent on tasks, error rates, and completion rates) will be automatically recorded by the VR platform. These logs will provide quantitative insights into user engagement and task performance during the intervention.
- **Posttest Assessment**: After completing the VR intervention, participants will undergo the same focus assessment as in the pretest. This will allow a direct comparison of attention-related metrics before and after the intervention.
- **Qualitative Feedback:** Participants will complete a brief usability survey and engage in semi-structured interviews post-intervention. These feedback tools will explore subjective experiences, perceived benefits, and challenges associated with the VR platform.

Data Collection and Analysis

1. **Quantitative Analysis**: Pretest and posttest scores will be compared using paired t-tests or ANOVA to identify statistically significant improvements in focus. Interaction logs will undergo descriptive and inferential analysis to evaluate engagement patterns.
2. **Qualitative Feedback**: Thematic analysis will be applied to interview transcripts and survey responses to identify key insights into usability and user satisfaction.

Expected Outcomes

- This study aims to demonstrate the effectiveness of VR-based interventions in enhancing focus among young adults with ADHD. The anticipated outcomes include measurable improvements in attentional capacity as indicated by pretest and posttest scores and insights into user preferences for VR features that support focus.
- In the long term, the findings could inform the design of personalized VR-based tools for ADHD management, contributing to the development of scalable, non-pharmacological treatments. This work could also guide future research into adapting VR interventions for diverse ADHD populations, including older adults and adolescents, and exploring their potential integration into broader therapeutic programs.

Platform/App Selection

A suitable VR platform will be selected based on specific criteria to ensure accessibility and usability for young adults with ADHD. Key considerations include intuitive navigation, customizable difficulty levels, and minimal cognitive load for users. Features like audio-visual cues and real-time feedback will accommodate diverse user needs, including those with sensory sensitivities. If no existing platform meets these requirements, a new environment will be developed, emphasizing user-centric design principles with iterative testing to ensure accessibility.

Implementing a VR platform for ADHD-focused interventions may involve challenges such as ensuring hardware compatibility, minimizing motion sickness, and optimizing performance on accessible devices. To address these risks, the selected or developed platform will undergo rigorous testing for stability, responsiveness, and user comfort. Backup solutions, such as simplified VR environments, will be prepared to mitigate potential hardware or software issues during the study.

5. Research Table (Logic Model)

Research Question	Data Sources	Methods	Expected Outcomes	Resources Needed
Research Aim 1: To investigate the effectiveness of VR-based interventions in enhancing focus among young adults with ADHD.				
Q1: **How does VR immersion impact the focus duration and intensity in young adults with ADHD during task-oriented activities?**	- Pretest and posttest focus scores - Observational data during VR sessions - Participant self-reports	- Pretest-posttest design - Observational analysis - Self-report assessment	- Increased posttest focus duration and intensity compared to pretest - Insights into VR's impact on sustained focus	- VR headsets - Focus assessment tools - Quiet testing environment
Q2: **What role does gamification in VR play in maintaining and improving focus levels among this demographic?**	- Session interaction logs - Participant feedback surveys on engagement - Task completion times	- Interaction log analysis - Post-session surveys - Task performance analysis	- Identification of effective gamification elements that support focus improvement	- VR software with customizable gamification options - Survey tools
Research Aim 2: To explore the usability and user experience of VR-based focus enhancement tools for young adults with ADHD.				
Q1: **What features of VR environments are most effective in maintaining user engagement and reducing distraction?**	- Feedback on specific VR features (e.g., sounds, visuals) - Interaction logs during VR sessions	- Post-session feedback forms - Feature analysis of participant preferences	- Identification of preferred VR features that support user engagement and minimize distractions	- VR environment with customizable features - Feedback survey tools

Q2: **How do young adults with ADHD perceive the usability and accessibility of VR-based interventions designed to improve focus?**	- Usability survey data - Semi-structured interviews on user experience - Self-reported comfort levels	- Survey analysis - Thematic analysis of interviews	- Insights into usability and areas for improvement in VR intervention design for ADHD-related focus	- VR headsets - Survey and interview tools - Quiet space for interviews

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