

Le Petit Care: A Child-Attuned Design for Personalized ADHD Symptom Management Through AI-powered Extended Reality

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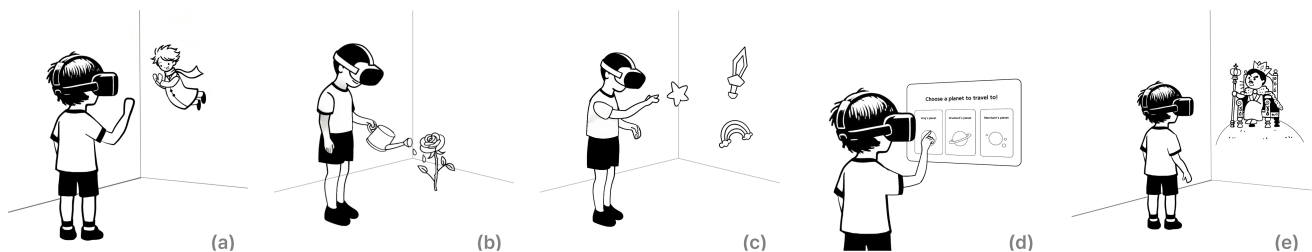


Figure 1: *Le Petit care* functions according to the following framework. (a) Users interact vividly with the character, (b) take care of the rose, and (c) collect various emotions as fuel. The data gathered through these processes is utilized for AI-based ADHD symptom screening, which not only enhances the understanding of symptoms but also (d) provides personalized behavioral development solutions. Children (e) participate in a storytelling-based program, helping to improve ADHD symptoms.

Abstract

Le Petit Care is an AI-powered extended reality solution designed to complement limitations in medication by providing highly user-efficient and personalized management of ADHD symptoms. It aims to alleviate children's sense of negative self-identity and guilt throughout the diagnostic and treatment process. We conducted expert interviews and interdisciplinary literature reviews to explore a practical design approach. By thoughtfully understanding children with ADHD, we aimed to integrate their unique characteristics into a user-centered design and storytelling framework. *Le Petit Care*, an extended reality program designed with this approach, uses AI to analyze multifaceted data such as head movements, eye tracking, behavior, and voice based on the internationally recognized diagnostic standard DSM-5 to screen for ADHD. Building on this analysis, it provides personalized behavioral development training

solutions. In this article, we describe a comprehensive approach that integrates insights from interdisciplinary research, suggesting an innovative solution for effective therapeutic interventions for ADHD.

CCS Concepts

• **Human-centered computing** → **Human computer interaction (HCI)**;

Keywords

Digital Therapeutics, Extended Reality, Artificial Intelligence, User-Centered Design

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1 Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that primarily emerges in childhood, leading to

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mental health deterioration and academic challenges for individuals, as well as imposing burdens on society as a whole. According to statistical data, the global prevalence of ADHD among children aged 3 to 12 is estimated to be approximately 7.6% (95% confidence interval: 6.1–9.4%). The prevalence tends to decrease with age, reflecting the tendency for symptoms to diminish or subside as individuals transition into adulthood [17]. Given this context, implementing appropriate therapeutic interventions for ADHD during childhood is of paramount importance.

Therapeutic intervention, in this case, involves not only the alleviation of symptoms but also a focus on comprehensive mental health and emotional well-being, while promoting the restoration of normal daily functioning. A thorough analysis conducted in the UK and Europe estimates that the annual cost of ADHD is approximately \$42.5 billion, comprising \$13.6 billion in education, \$7.9 billion in health and mental health, and \$21.1 billion in crime and delinquency [6]. In conclusion, designing effective solutions for therapeutic interventions in ADHD emphasizes enhancing individual quality of life and reducing societal costs.

Medication is considered the most effective treatment for ADHD, but children often experience guilt and psychological burdens during diagnosis and treatment. Research shows that a diagnosis misaligned with self-identity can harm self-image, amplify feelings of abnormality, and increase social stigma. This misalignment may lead to social isolation and anxiety about the future, especially when it negatively impacts peer relationships [12]. These issues cannot be solved with medication and personalized intervention strategies are important.

Methods such as play therapy, social skills training, and cognitive behavioral therapy have been proposed to address this issue. Still, their effectiveness is often constrained by challenges, including a narrow focus on specific symptoms, limited accessibility, and difficulties in objectively evaluating their impact [5]. Digital therapeutics are evidence-based software solutions designed to treat or manage medical conditions. Their key characteristics, such as high accessibility and the use of personalized data, make them an effective approach to addressing these issues. However, existing digital therapeutics for ADHD often face challenges, such as failing to capture diverse symptoms, and reducing user utility. These challenges highlight the need to explore practical design approaches for developing more effective and accessible solutions.

To align with the UN's Sustainable Development Goal of ensuring good health and well-being, we focused on understanding and addressing the unique needs of children with ADHD. Building on this problem, we conducted extensive research to generate insights and refined our ideas using design methodologies. Through an interdisciplinary approach, integrating expertise from medicine, computer science, visual design, and biological science, we propose a framework to overcome limitations in existing digital therapeutics.

2 BACKGROUND AND RELATED WORK

The diagnosis and medication of children with ADHD may lead to negative self-perceptions during a critical period of identity formation. According to previous studies, when a diagnosis conflicts with a child's self-concept, it can threaten their self-image, reinforce

stigma, highlight gaps with peers, and result in social isolation and anxiety about the future [12]. Additionally, ADHD medication can cause children to perceive themselves as different, leading to low self-esteem and the development of a negative self-concept. These negative experiences can potentially lead to conditions such as depression or antisocial personality disorder, which may interfere with effective ADHD treatment [9]. Digital therapeutics offer an effective solution to these challenges through data-driven personalized symptom management, exceptional accessibility, and the flexibility to incorporate diverse therapeutic content.

We reviewed the key features of previous studies on digital therapeutics to explore their limitations and potential applications. EndeavorRx, an FDA-approved game-based treatment for children with ADHD, effectively improves attention but shows minimal impact on core symptoms like hyperactivity and impulsivity [13]. Additionally, its low user utility and lack of immersion contributed to limited market success. RECOGNeyes, leveraging eye-tracking technology, enhance visual attention and working memory but is constrained by its exclusive reliance on visual stimuli, limiting its ability to address diverse ADHD symptoms [19]. Addressing these technical challenges while maximizing user utility and ensuring a user-friendly design remains a critical challenge in advancing digital therapeutics for ADHD.

Recent Advancements in Artificial Intelligence (AI) and Extended Reality (XR) offer opportunities to overcome the limitations of current digital therapeutics by delivering immersive and adaptive health solutions [8]. Meanwhile, successful examples of addressing children's psychological and emotional needs in medical settings demonstrate the impact of user-centered design. A notable case from Stanford Design School tackled the extreme anxiety children experience during MRI procedures, caused by the confined environment. By transforming the MRI experience into immersive themes like underwater adventures, space journeys, or pirate encounters, they alleviated fear and created a positive, engaging atmosphere [10]. The advancement of technologies, combined with a human-centered design approach, highlights the potential for developing innovative digital therapeutics tailored to meet the needs of children with ADHD.

3 RESEARCH AND DESIGN APPROACH

In our design process, we adopted a mixed-method approach combining expert interviews and literature reviews. To gather diverse perspectives, we conducted in-depth interviews with a child studies professor, a psychiatrist, and a digital healthcare venture CEO. Insights from these interviews guided an extensive interdisciplinary literature review, which informed and refined our design approach.

3.1 Expert Interviews

Insights from an interview with a child studies professor reveal that children with ADHD struggle with working memory and attention span, impacting their ability to selectively process visual and auditory information. These findings highlight the importance of adapting environments to reduce stimuli and provide consistent feedback. Visual designs should eliminate unnecessary elements and use a non-distracting color palette, while auditory designs must

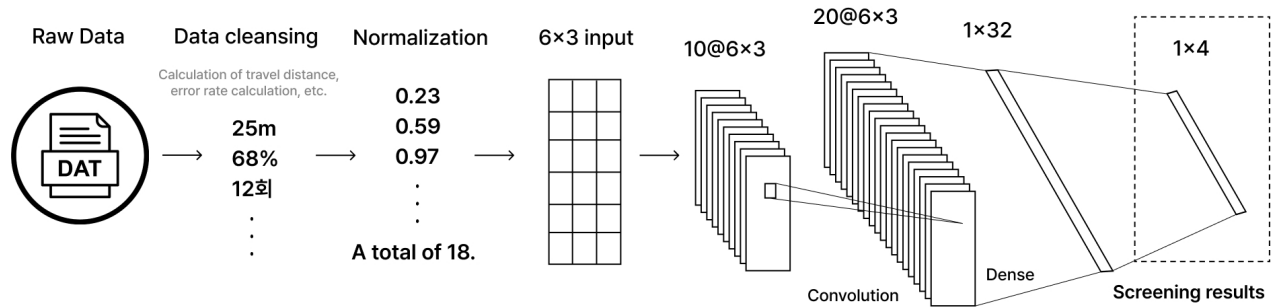


Figure 2: In an XR environment, raw data—including gaze, movement, and reaction time—are collected and analyzed to extract key features. A trained model with optimized weights then processes new user data, enabling high-accuracy ADHD screening.

reduce background noise and offer clear instructions. Such strategies are vital for improving attention, comprehension, and learning outcomes for these children.

The interview also noted that social stigma and misunderstanding of ADHD harm affected children’s self-esteem and emotional development. When parents understand their child’s problematic behavior as a sign that they need help and support, rather than just a discipline issue, it can improve treatment outcomes and help children with ADHD build a positive self-identity while creating a better learning and living environment. Furthermore, integrating data from digital therapeutics has become increasingly important, providing a means to guide meaningful and data-driven management strategies.

A psychiatrist advised on data-driven approaches to ADHD screening and personalized symptom management. An XR-based screening tool that combines voice recognition, immersive interactions, and tracking of head, hand, and eye movements could address the limitations of current systems. The DSM-5, as the official guideline for diagnosing and classifying mental disorders, is commonly used by mental health professionals worldwide. Existing Computerized Adaptive Testing (CAT) tools reference DSM-5 standards but are not fully aligned with them. Therefore screening systems utilizing XR technology, while also not perfectly adhering to DSM-5, can still offer a meaningful approach. At this design stage, prioritizing practical consistency and applicability could be more critical than full alignment with complex diagnostic standards, focusing on achievable progress and incremental improvements.

A digital healthcare expert discussed practical design for wearable digital therapeutics, particularly head-mounted displays (HMDs). Key drawbacks identified include heaviness, physical inconvenience, and motion sickness. While addressing these issues is essential, the expert emphasized that resolving technical problems alone is not enough—the product’s utility must outweigh its inconveniences. Successful HMDs depend on a clear purpose and delivering tangible value to users, balancing sustained usability with overall utility. High data screening accuracy for personalized programs builds user trust and encourages continued use, which is crucial for long-term success.

3.2 Literature Review

Expert interviews emphasized the importance of addressing the cognitive needs of children with ADHD in program design to minimize burden, consider their unique characteristics, and enhance usability for sustained engagement. To integrate these insights, extensive literature reviews in biological science, visual design, and play therapy were conducted.

Children with ADHD often have lower dopamine levels, weakening the signal transmission of S-cones sensitive to blue hues. This deficiency forces the brain to overcompensate during early visual processing—evidenced by increased P1 amplitude—requiring more cognitive resources to interpret blue hues [7]. As a result, ADHD individuals show decreased performance with blue-yellow interfaces and improved efficiency with medium- to long-wavelength colors such as red, green, and orange (figure 3). To reduce visual strain and enhance performance in virtual environments for these children, user interfaces should prioritize these longer-wavelength colors [18]. Additionally, since children often have limited reading skills and excessive text can cause motion sickness in XR settings, user interfaces should minimize textual content and instead incorporate intuitive graphical elements, ensuring information is easily understood without overwhelming young users [4].

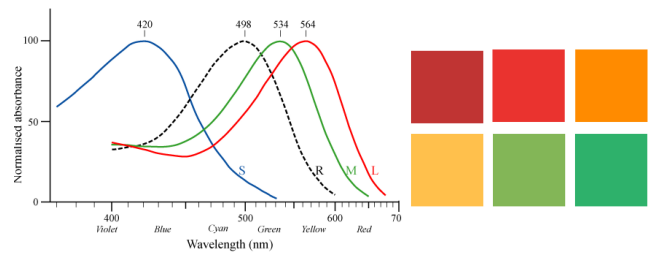


Figure 3: (A) Distribution of colors across different wavelengths [2]. (B) A color palette featuring recommended object colors to minimize visual strain.

Furthermore, children with ADHD often exhibit short attention spans, limited ability to shift focus between tasks, and difficulties

Table 1: Design Requirements and Rationale

Requirements	Design Rationale	Features
User Utility	Emotional connection with characters in a story enhances sustained engagement and therapeutic effects [1].	Encouraging emotional connections and self-discovery through the narrative framework of <i>'The Little Prince'</i> .
	Reducing social stigma and negative self-perception supports emotional development and sustained therapeutic engagement.	Immersing users in the narrative fosters emotional growth and instills a sense of achievement
Cognitive Needs	Children with ADHD can quickly lose interest if they are not initially engaged or if the difficulty level is unsuitable.	Characters engages children who struggle with reading by providing guidance through voice and gestures. Enhancing motivation through personalized gamification.
	Minimizing visual strain and distractions enhances attention and engagement.	Color palettes focusing on mid-to-long wavelengths such as green and red are used to minimize cognitive load for children with ADHD. Intuitive graphic elements replace excessive text, with key objects enhanced by vibrant colors and glowing effects to reduce environmental distractions.
Personalizing	Delivering personalized treatment solutions by analyzing behavioral and environmental data quantitatively.	XR-based immersive tools using eye tracking, head movement, and voice recognition to capture behaviors that traditional methods might overlook. Adapting DSM-5 diagnostic criteria to user-specific data and leveraging AI models for ADHD screening. Offering personalized behavior development solutions tailored to individual screening results, focusing on six key areas: attention, working memory, executive functions, impulse control, behavioral regulation, and emotional regulation [3]

engaging in complex activities due to poor attention distribution. They are prone to losing interest and ceasing play if the initial scenes of a game fail to engage them, and real-world stimuli can further disrupt their focus on virtual interfaces. To address this, virtual objects were designed with eye-catching shapes, vibrant colors in 3D graphics, and glowing effects to capture and sustain their attention effectively [15].

Expert interviews also highlighted the lack of child-centered approaches in digital therapeutics. Research indicates that storytelling and gamification significantly enhance engagement and therapeutic outcomes. Systems incorporating fairy tale narratives and progressive difficulty—such as the "Fairy Tale Directed Game-Based Training System" and previous studies—demonstrate increased motivation, attention, and sustained participation, underscoring the value of these strategies in optimizing ADHD management [1, 16].

The development of a personalized management program for ADHD requires the quantitative analysis of user data based on specific criteria. In psychiatry, where clear biological markers are lacking, diagnostic tools often rely on symptom and behavior assessments. The ADHD Rating Scale (ADHD-RS) is an 18-item questionnaire based on the DSM-5, providing a reliable criterion for assessment. However, since it relies on evaluations from parents and teachers, it has limitations in symptom assessment. As a result, technologies such as CAT have proven useful as methods to

quantify mental health symptoms while minimizing environmental influences.

Recently, advancements in technology have facilitated research leveraging eye-tracking and artificial intelligence (AI) to detect speech and movement patterns that traditional methods might overlook [11]. By combining ADHD-RS with existing XR and AI-based screening technologies [14], tailored symptom management solutions can be designed. XR creates immersive three-dimensional environments, allowing for the observation and measurement of real-world behaviors in a simulated context. With built-in sensors and computing capabilities, XR devices can seamlessly capture, process, and transmit data such as head movements, hand gestures, eye tracking, and voice input.

4 Design Process

Based on the design approach, the concept of *'The Little Prince'* was proposed as an inspiring design framework. We designed a storytelling-based program utilizing the narrative of *'The Little Prince'*, which explores themes of bonding and self-discovery, to help children with ADHD alleviate negative self-identity.

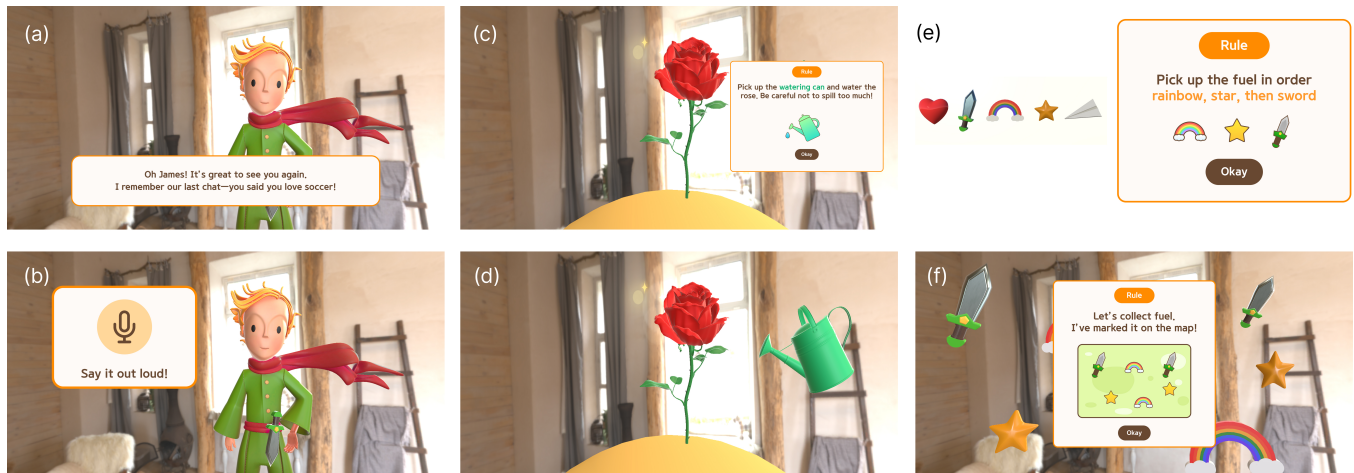


Figure 4: These scenes illustrate the ADHD screening process through immersive gameplay. In (a, b), the player interacts with *the Little Prince*, by analyzing speech and movement for social and hyper-activity markers. The (c, d) tests self-regulation and focus through *the Rose-care* tasks. The (e, f) evaluates working memory and executive function by guiding players to collect resources in sequence.

4.1 Effortless ADHD Symptom Screening through Immersive Content

The opening sequence includes simple tasks like interacting with *the Little Prince*, caring for *the Rose*, and finding airplane fuel, allowing the effortless generation of diagnostic datasets for ADHD screening. To engage children with ADHD, who may lose focus if initial scenes are unappealing, the game begins with *the Little Prince* asking questions and providing LLM-powered answers (Figure 4 a,b). The character offers ongoing guidance through voice and gestures, reducing reliance on text and enhancing immersion. *The Little Prince* wears a green coat with a red lining, colors that minimize visual strain. Over multiple playthroughs, he evolves from awkward to warmer and more personal, remembering past interactions. Across all sequences, the XR device collects user data, including voice frequency and movement vectors such as head, wrist, and eye movements. The dialogue mission is designed to evaluate social skills and impulse control.

Subsequent mission, caring for *the Rose*, assesses self-regulation, impulse control, and attention. Players perform tasks such as watering *the Rose* steadily or shielding it from sandstorms, with random distractions like harsh weather. Diagnostic metrics include time spent away from *the Rose* and improper task execution (Figure 4 c,d). To operate the airplane, players collect emotional and symbolic resources (e.g., hope, starlight, courage) designed in medium-to-long wavelengths to reduce cognitive load. These tasks test working memory and executive function, with the UI guiding players to collect resources in a specific order (Figure 4 e,f). The system measures performance through metrics such as the number of incorrect picks and the time taken to complete the task.

Raw data extracted to measure inattention and hyperactivity-impulsivity undergo refinement before being processed by the AI model (figure 5) [14]. Based on ADHD-RS, the data obtained from diagnostic missions can not only be used to enhance personalized

symptom understanding but also help players improve their symptoms through tailored behavioral development training designed to enhance attention, reduce impulsivity, and develop social skills. These sequences can be used to repeatedly screen for ADHD and continuously manage symptoms by providing a consistent evaluation environment while incorporating variable-level design in each playthrough. By conversing with *the Little Prince*, caring for the delicate *Rose* vulnerable to the space environment, and gathering all the fuel for the spaceship, the player will be ready to embark on a journey to new planets with them. Afterward, the player can continue an adventure to planets that provide personalized behavioral development solutions based on screening data.

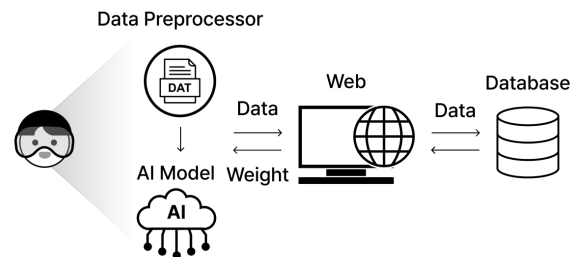


Figure 5: The system architecture of an AI-based ADHD screening phase derived from raw data through XR

4.2 Enhancing Developmental Abilities and Building Self-Efficacy Through Storytelling

The behavioral development mission tailors its difficulty and scenarios based on individual pre-screening results. Players explore narrative-driven planets and interact with a variety of characters, such as *the King*, *the Drunkard*, and *the Merchant*. For example, on *the King's Planet*, players participate in an emotion-matching game designed to improve social skills and working memory. In this scenario, *the Little Prince* uncovers the King's lack of empathy, hidden behind his authoritarian demeanor. Players assist the King in understanding others' emotions by choosing appropriate responses to different emotional situations (Figure 6).

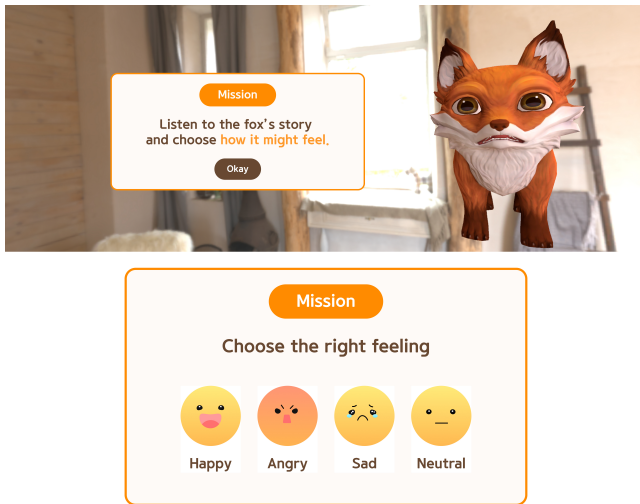


Figure 6: Emotion Matching Mission on *the King's planet*

When players make the right choices, *the King* learns empathy and communication skills, while players build their own confidence. This journey emphasizes empathy as the essence of true leadership, surpassing mere authority, while also helping players improve their attention, impulse control, and social interaction skills. Through engaging narratives with *the King* and other characters, players experience a meaningful journey that not only alleviates ADHD symptoms but also boosts self-efficacy. This game offers more than entertainment—it delivers educational and functional value, encouraging players' continuous growth [3].

5 PROTOTYPING AND FEEDBACK

We developed *Le Petit Care* using *C#* and *Unity*, leveraging the *Metalense 2* AR glasses for prototype development due to their reduced weight and lower risk of motion sickness compared to VR HMDs. To assess the system's usability and user experience, we conducted a preliminary user study with seven participants, gathering qualitative feedback on interaction design and user immersion.

A major usability issue identified during the evaluation was the microphone-based voice dialogue system. Participants reported that conversations with *the Little Prince* were excessively long, repetitive, and tedious. For instance, *P1* noted, "The conversation was too long, making it difficult to stay focused," while *P4* stated, "The

dialogue felt monotonous and boring, making it easy for children to lose interest." These findings suggest that the prolonged and repetitive nature of the dialogue may hinder user immersion and engagement, particularly among younger users. Additionally, participants encountered difficulties in *the Rose* Interaction Mission, struggling to understand the task and its objectives intuitively. *P3* mentioned, "The mission objective was unclear, so I didn't know how to proceed," whereas *P6* remarked, "There was a lack of visual hints, making it hard to instinctively interact with the objects." These insights indicate that the mission lacked sufficient visual feedback and affordances to effectively guide user interaction, highlighting the need for improvements in interaction design to enhance clarity and intuitiveness.

Moreover, A psychiatrist's review suggested enhancements for diagnostic specificity. One of the suggestions was to estimate not only incorrect responses, which had been previously measured but also correct responses. This approach would enhance the accuracy of attention assessment, ensuring a more balanced evaluation of users' attentional and performance capabilities. Additionally, for analyzing impulsivity-hyperactivity traits, it was suggested to incorporate context-aware behavioral metrics, such as detecting whether the AR glasses were impulsively removed. Also, it also noted constraints in detecting leg shaking and hand-tracking movements beyond the detection range of XR devices, highlighting the potential for refinements to improve the reliability of the data.

6 CONCLUSION AND FUTURE WORK

The medication-based approach to ADHD treatment has proven effective in alleviating symptoms. However, it does not fully address critical challenges such as identity confusion, social stigma, and the psychological burdens experienced by patients. Rather than merely focusing on symptom alleviation, our approach incorporates data-driven screening and delivers personalized self-efficacy enhancement content. By prioritizing practical value and user utility, this framework aims to help individuals better manage their ADHD, ultimately fostering greater self-awareness and improving their quality of life.

Building on previous XR-based AI diagnostic research that refined AI models using data from over 2,000 children [14], our design has the potential to enhance screening accuracy. However, for AI-driven screening and treatment systems to be practically viable, extensive data collection and rigorous validation are essential. The effectiveness of AI models heavily depends on data quality, and additional algorithms or Outside-in Trackers could improve diagnostic accuracy. Furthermore, should future research yield a precise and comprehensive understanding of the neurobiological mechanisms underlying ADHD, these AI-driven screening systems could potentially complement or even replace traditional diagnostic methods. This advancement would enhance diagnostic objectivity and accessibility, facilitating early detection and intervention, ultimately improving outcomes for individuals with ADHD.

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