

Design of Hide-and-Seek Game for ADHD Children Based on AR Technology

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Abstract. The main reason why children with Attention Deficit Hyperactivity Disorder (ADHD) are marginalized in traditional team games is that their behavioral characteristics and rules are difficult to match. The current research on augmented reality mainly focuses on cognitive training, often treating hyperactivity as a deficiency to be corrected. However, the core dilemma faced by children in the context of free social games has not yet been resolved. To fill this gap, a Hide-and-seek game based on AR technology was proposed in this study, aiming to transform the physiological characteristics of ADHD children from gaming disorders to design resources. By comparing and analyzing the extracted three-layer transformation logic, its implementation relies on four core modules. The interactive prototype is transformed from this mechanism through AR spatial anchoring and gesture recognition technology, ultimately enabling the construction of a complete user process. From a societal perspective, a low stress and high inclusive gaming experience has been created for children with ADHD. From an industry perspective, the innovative model of special needs users shifting from adaptation targets to design drivers has been explored.

Keywords: Children with ADHD, Augmented reality, Inclusive design, Gamification

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD), as one of the most common neurodevelopmental disorders in childhood, affects approximately 5% -7% of children and adolescents worldwide [1]. The three core symptoms of ADHD mainly focus on inattention, hyperactivity, and impulsivity. These behaviors cause them to be frustrated when playing group games with their peers. Represented by Hide-and-seek game, players keep their bodies still at critical moments, follow multi-step game rules, and accept the elimination mechanism. Their hyperactive and impulsive physiological characteristics are often interpreted as disruptive and unruly. Cognitive executive deficits have a dual impact on the gaming experience of children with ADHD. Firstly, motivational dissonance triggers emotional instability and selfish reciprocity tendencies [2], further disrupting interactions with peers. Secondly, insufficient conversion between working memory and cognitive abilities makes it difficult for children to understand and follow rules [3], resulting in a disadvantage in gaming. This core contradiction seriously affects their social development and self-identity construction. Their popularity is much lower than that of their peers and they are often marginalized by the group. Friendship patterns are mostly one-way [4]. 52% of ADHD children are easily

excluded by their peers, with a higher rate of isolation than ordinary children. They also have a stronger sense of loneliness when it is difficult to establish two-way friendships.

In recent years, Extended Reality (XR) technology has provided possibilities to address this core contradiction, especially Augmented Reality (AR) technology. Firstly, AR cognitive training tools have been developed to allow children to track virtual objects to maintain focus, verifying a significant increase in their engagement [5]. But the platform focuses on the single player task operation mode and has not yet responded to the core social dilemma of ADHD children being excluded and eliminated in games. Secondly, existing AR interventions mostly follow the logic of correction, treating ADHD children's hyperactive behavior as a target that needs to be measured and controlled, while ignoring its potential as an interactive resource [6]. Compared to VR intervention, AR has the feature of virtual real fusion. Allowing children to receive interventions in real physical environments and social interactions to transform their skills into effective daily life skills [7]. Therefore, AR intervention needs to shift from inhibition of hyperactivity to behavioral empowerment. There have been several exploratory practice cases of XR technology in the field of special child intervention. Floreo as a medical grade VR platform, helps children with autism practice social scenes in a safe and controllable virtual environment. Clear goals and steps effectively reduce users' anxiety and risk, but their intrinsic motivation is insufficient and they rely on external factors, which limits the platform's space and lacks scalability and personalized features. Impulse: Playing With Reality is a MR art project that transforms the physical impulses of people with ADHD into visual feedback, expressing that hyperactivity can be seen as a form of creativity. The physiological feedback generated through interaction is limited and lacks emotional and narrative coordination. For a long time, it is difficult to maintain the participants' attention and unable to immerse themselves in the role to generate profound emotional resonance. Therefore, game platforms targeting the social and emotional needs of children with ADHD are a clear gap in existing research. The key to solving this problem is to create a low stress, highly inclusive gaming environment for children with ADHD, and to create a new type of social way for them to enhance their sustained enthusiasm. Therefore, this study proposes gamification design based on augmented reality technology, which designs its behavior into game mechanisms through the concept of feature transformation, thus filling the gap in this field. And ultimately build a complete user experience process, expanding new perspectives on inclusive design.

2. Methodology

This study proposes a design framework for children with ADHD aged 5-12 based on AR technology. The game is based on Hide-and-seek game and has reconstructed a new rule system through AR technology, transforming their physiological characteristics from an obstacle to the core process of the game. Players wear AR glasses to hide and search for virtual clues in real physical spaces such as park corners, community squares, schools, etc., to experience the fun of gaming and turn public spaces into interactive gaming environments. Real gaming dilemma based on ADHD children. The game breaks the elimination rules of traditional games by using team confrontation, and ensures that players can participate in the entire process through four core game mechanisms. Through this multi person outdoor AR game platform, children can experience inclusive game rules without punishment or elimination mechanisms through physical interaction in a familiar environment. Help them accumulate positive gaming experiences and self-identity. The specific game rules and user processes will be explained in detail below.

2.1. Characteristics of ADHD children and the logic of game mechanism transformation

The core of the game rule design is to make the game suitable for children with ADHD. Therefore, based on their real dilemma as the basic principle, this study reconstructed the game mechanism and designed three core design modules: superpower acquisition, identity transformation mechanism, and character achievement card. Integrate into a closed-loop logic that adapts to its behavioral characteristics.

2.1.1. Physiological layer: transforming "hyperactivity" into a way to acquire resources

Children with ADHD have difficulty maintaining physical stillness, which affects their daily functioning and social participation [8]. Traditional Hide-and-seek game requires stillness at critical moments, making their behavior in opposition to the rules. This study focuses not only on whether they can complete the task, but also on how they "complete it". The interaction process between perception, cognition, and movement can better reveal behavioral characteristics than the results [9]. Therefore, this game is driven by body interaction as the core and embedded with the principle of operant conditioning. It seeks to unlock abilities by completing tasks through body movement, while hiders need to complete tasks to acquire abilities to maintain concealment, turning physical activity into game motivation to guide positive behavior (Table 1).

Table 1. The correspondence between the four major modules and the three-layer argumentation

Core characteristics of ADHD	Difficulties in traditional games	Conversion mechanism
Hyperactivity	Motion=Exposure=Loss	Move=Super Power=Win
Difficulty understanding rules	Memory multi-step instruction	Step-by-step task chains
Low resilience tolerance	Outing humiliation	Identity transformation

2.1.2. Cognitive layer: transforming "abstract rules" into spatialized guidance

Traditional games rely on language rules and memory to increase the cognitive load of children with ADHD. The core of game design for children with ADHD is to maintain a balance between participation, immediate feedback, and cognitive ability [10]. In order to reduce the cognitive load on players, a special superpower module has been designed in the game mechanics. Acquiring superpowers requires collecting fragments. Some fragments will randomly scatter on the ground and can be picked up directly, while others require completing three progressive subtasks through commands to unlock. When all fragments are collected, the superpower can be unlocked. The advantage of this is that there are instructions to guide players on what to do at the current stage, without the need to memorize all the complex steps.

2.1.3. Emotional layers: reshaping the motivation from 'failure to exit' to 'switching sides to continue'

Children with ADHD have weaknesses in emotional and impulse control compared to ordinary children, which can easily lead to social conflicts. The elimination mechanism in traditional games further exacerbates these conflicts. This study designs two mechanisms, identity conversion and role achievement card, to replace the original elimination rules. The identity conversion mechanism allows captured players to remain active on the field by switching to the opposing faction, overturning the rule of failure and exit, effectively alleviating players' frustration and psychological

burden. In each duel, players contribute differently and the types of cards they receive also change accordingly. And showcase it at the end of the game to stimulate a more lasting enthusiasm for participation.

2.2. Practical application of augmented reality technology

The focus of this study is to build a game experience for players that does not require language explanation or memorization of written rules, has less pressure, and is highly inclusive, and is implemented using AR technology (Figure 1). In order to make the physical space more intuitive, the fusion of ARCore/ARKit and real physical environment coordinates is used. The game system marks the position of the hidden person in real time with a semi transparent triangle, and the interface displays the specific distance value when the seeker approaches the target. Overlaying virtual content onto the real world can alleviate users' psychological burden and tension [11]. With the help of hand tracking and body tracking technology, the behavioral characteristics of ADHD children have been transformed into skills in games. The level of social interaction and attention span can be significantly improved through the combination of physical contact and immediate feedback [12].



Figure 1. AR game interface (picture credit: original)

2.3. User flow

The content of this section mainly revolves around the user experience process of AR hide and seek game. The core logic is to make the rules fit the characteristics of ADHD children, rather than forcing them to follow the rules. By gradually advancing, assist them in transitioning from mastering the basic gameplay of the game to engaging in real combat.

The experience of being excluded by peers in the past can cause ADHD children to develop resistance emotions, thereby weakening their willingness to experience real games. Therefore, 5 to 8 minutes were specially reserved before the official competition as an adaptation phase (Figure 2). By simulating games with virtual partners, one can become familiar with the gameplay and system operation experience, laying the foundation for entering real games in the future. If this stage is not set up, players entering the game directly will face the dual pressure of rule understanding and game interaction, which can easily trigger cognitive load and resistance to the game platform.

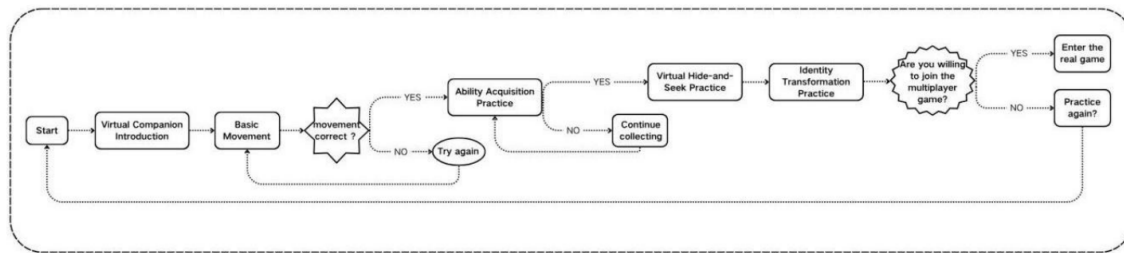


Figure 2. Guidance phase flowchart (picture credit: original)

After the guidance phase is completed, user will enter the official game section (Figure 3). The entire game lasts for 40 minutes and is divided into three stages: preparation stage (10 minutes), confrontation stage (20 minutes), and final stage (10 minutes).

During the preparation phase, players are required to wear AR glasses and make a faction selection, choosing to become Hider Group A or Seeker Group B. Group A familiarizes themselves with the site and finds their hiding place; Group B collects fragments through gesture tracking and completes three tasks to obtain superpowers and map prompts.

During the adversarial phase, Group A collects fragments through gesture tracking and completes three tasks to obtain superpowers and trigger fake position cursor/hidden position to maintain their hiding state; Group B uses superpowers to narrow down the range and uses the aperture of the map to track and locate the target.

In this stage, an identity conversion mechanism is set up. If a hideout is caught, they will not be eliminated, but will switch factions to become a seeker to help the seeker win.

In the final stage, all skills fail and enter a fair showdown. After the game ends, victory will be determined based on certain conditions (if there are still hiding individuals who have not been caught by the deadline, the hiding individuals will win; if all hiding individuals have been caught, the seeker will win). Based on the player's contribution in the game, independent achievement cards will be issued, and all cards will be collected to exchange for prizes.

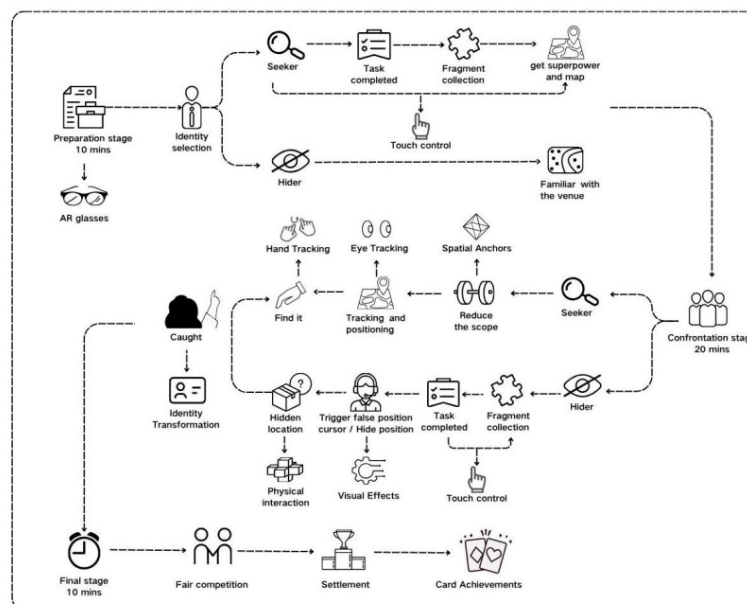


Figure 3. Game development and user process (picture credit: original)

3. Discussion

This study proposes an AR Hide-and-seek game aimed at meeting the core needs of children with ADHD. The limitations of traditional and digital games have been broken and the unique advantages of AR technology have been demonstrated. Compared to traditional gameplay, AR's spatial anchoring identity transition mechanism solves the dual dilemma of memory load and social frustration for players. Opened up a more inclusive participation path for emotionally sensitive groups. The natural social environment and free movement space are preserved by AR technology, which is more suitable for children with ADHD compared to digital games. However, this study also has several limitations. Firstly, the current game design is only at the framework level and has not been empirically tested by real users. The understanding and acceptance of game mechanisms by ADHD children need to be confirmed through subsequent experiments. Secondly, the augmented reality technology relied upon by the game needs to run stably. Factors such as lighting and occlusion in outdoor environments may affect its performance. Therefore, the subsequent development needs to optimize the technical solution. Meanwhile, the role of the three-stage structure and ability system in children's cognitive load still needs to be carefully evaluated. Future research should take into account both technological optimization and humanistic care. On the one hand, comparative experiments need to be conducted and user survey questionnaires need to be used to measure participation and emotional changes. On the other hand, it is necessary to improve children's privacy protection and anti addiction mechanisms to ensure that the gaming experience complies with ethical norms. Making this game not only a play tool for children with ADHD, but also a shift in design paradigm from standard users to real individuals.

4. Conclusion

This study proposes a Hide-and-seek game design based on AR technology to address the core dilemma of ADHD children being excluded and eliminated in traditional games, filling the research gap of existing AR interventions focusing on cognitive training and neglecting social gaming experiences. The contributions of this study are reflected in the following aspects. Firstly, at the social level, a "low social pressure" group integration approach has been created to reconstruct the physiological characteristics of ADHD children into core resources for game mechanisms, which helps improve their social experience and self-identity. Secondly, at the level of design philosophy, a path of feature transformation has been explored, providing a new theoretical perspective for inclusive design for neurodiverse populations. Finally, in terms of game mechanics, the significance of elimination has been redefined through identity transformation mechanisms, providing them with a sustainable and inclusive way of participation. This study is still in the framework stage, and its effectiveness needs to be demonstrated through user testing and controlled experiments in the future. From a broader perspective, this study supports a more ambitious goal: to use the behavioral characteristics of ADHD children as a design resource for game mechanisms, breaking the traditional technology set uniform participation thresholds for standard users, and enabling special needs children to integrate into social games in their own way.

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