Environment and Social Psychology (2024) Volume 9 Issue 1
doi: 10.54517/esp.v9i1.1871

RESEARCH ARTICLE

Principles of environmental and social psychology in UI/UX design for metaverse social games: A case study of Horizon Worlds

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ABSTRACT

Design psychology and environmental and social psychology are two independent yet interconnected fields. This paper aims to integrate these fields and explore their application in user interface/user experience (UI/UX) design for metaverse social games. The principles of design psychology help understand users' cognitive and emotional needs, enabling the creation of user-friendly interfaces and interaction designs. On the other hand, principles of environmental and social psychology provide insights into how environmental and social factors influence user behavior and psychological states. Building upon the importance and application of design psychology principles in UI/UX design, we delve into the specific environmental and social psychology factors that impact UI/UX design in metaverse social games. As a virtual global social platform, the metaverse necessitates designers to consider users' social needs, identity expression, and personal interactions, in order to create an immersive and authentic virtual social experience. Through an in-depth analysis of Zuckerberg's "Horizon Worlds" and its UI/UX design, we explore the comprehensive application of design psychology and environmental and social psychology principles in metaverse social games. We examine aspects such as usability, personalization, social interaction, and emotional connection in UI/UX design and discuss how visual elements, sound effects, and interactive feedback can facilitate the establishment of emotional connections and social networks within the virtual world. This research aims to provide designers with deeper insights and guidance in creating metaverse social game interfaces that align with user needs and societal adaptability. It will further expand the theoretical foundation of UI/UX design for metaverse social games and serve as a case study and reference for empirical research on the application of environmental and social psychology in game interface design.

Keywords: environmental and social psychology; metaverse social games; UI/UX design; user cognition; virtual social experience

1. Introduction

Design psychology and environmental and social psychology are two distinct yet interrelated fields. This study aims to integrate them and explore their application in user interface/user experience (UI/UX) design for metaverse social games. Design psychology investigates the interactive relationship between user cognition, emotions, behavior, and design, focusing on fulfilling user needs and enhancing user experiences. On the other hand, environmental and social psychology examines how environmental and social factors shape individuals' cognition, emotions, behavior, and interactions, encompassing social, physical, and cultural environments.

ARTICLE INFO
Received: 29 June 2023 | Accepted: 18 September 2023 | Available online: 20 November 2023

CITATION
Gao B, Xie H, Wang Y, Xie Z. Principles of environmental and social psychology in UI/UX design for metaverse social games: A case study of Horizon Worlds. *Environment and Social Psychology* 2024; 9(1): 1871. doi: 10.54517/esp.v9i1.1871

While their research foci may vary, design psychology and environmental and social psychology can complement and combine with each other. In UI/UX design, it is crucial to consider the interaction between users and the environment, as well as the impact of social factors on user behavior. The principles of design psychology assist designers in understanding users' cognitive and emotional needs, facilitating the creation of user-friendly interfaces and interaction designs. Meanwhile, the principles of environmental and social psychology offer insights into how environmental and social factors influence user behavior and psychological states.

This study aims to provide a deep exploration of the environmental and social psychology principles in UI/UX design for metaverse social games, using Mark Zuckerberg's "Horizon World" as a case study. By integrating design psychology and environmental and social psychology principles, we will investigate how to create interface designs that align with user needs and societal adaptation in metaverse social games. Specifically, we will examine aspects such as interface usability, personalization, social interaction, and emotional connections, exploring how visual elements, sound effects, and interactive feedback can guide players in establishing emotional connections and social networks within the virtual world. Through empirical research cases and references, we hope to provide designers with profound insights and guidance, contribute to the theoretical foundation of UI/UX design for metaverse social games, and enhance user experiences and satisfaction.

2. Literature review and theoretical foundation

2.1. UI/UX design in metaverse social games

User Interface (UI) serves as the medium for interaction and information exchange between systems and users[1]. In the context of gaming, UI refers to the user interface within the game. Game UI acts as the medium through which players interact with the game system[2]. Players can perform various actions in the game world by interacting with the game UI, such as clicking on icons, accessing equipment details, character information, game information, and more, thereby achieving their interactive goals with the game.

User experience (UX) refers to the purely subjective psychological feelings that users develop during the process of using a product[3]. User experience is primarily manifested in three dimensions: the user, the product, and the interaction[4]. In gaming, user experience is mainly reflected in the subjective experiences and perceptions that the game's interaction provides to the players. The user experience in gaming focuses on the players' psychological activities, behavioral habits, and thinking patterns, offering visual, interactive, emotional, and sensory experiences throughout the gaming process, and more.

The purpose of UI is interaction, making UI/UX Design and interaction design mutually complementary[5]. As a mediator between players and games, game UI facilitates interaction through interface and interaction design. A well-designed UI interface enhances the player's interactive experience, leading to greater immersion in the game[6]. Conversely, poor UI/UX design diminishes the player's interactive experience, resulting in a loss of motivation to continue playing and potential user churn. Therefore, when designing the UI interface for games, it is essential to consider factors related to interaction design.

During game design, designers fully integrate the principles of design psychology into the design of game UI interfaces. Guided by player behavior patterns and psychological effects, designers employ these principles to create interactive designs in the UI interface, establishing a connection between players and the game. By satisfying players' diverse UI needs and ensuring their comfort during interactions, designers can optimize the design of the game's UI interface, providing a better user experience.

The UI in metaverse social games serves as the interface through which users interact with the game,

including elements such as menus, buttons, icons, labels, etc. UI/UX design needs to consider user experience, usability, and visual effects to provide a seamless interactive experience. The focus of UI/UX design in metaverse social games is on how users effectively interact with the game. It encompasses designing user workflows, interaction methods, feedback mechanisms, and more, aiming to deliver an intuitive, efficient, and enjoyable user experience. The core aspect of metaverse social games is social interaction. Specifically, social feature design includes establishing friendships, chatting, participating in shared activities, sharing content, and more, to foster connections and communication among players. Players have the ability to create and customize their own character avatars within the metaverse social game. This includes selecting physical features, clothing styles, personalized decorations, etc., allowing players to express their individuality and identity within the virtual space. Additionally, effective UI/UX design should provide clear feedback and animations, enabling players to receive accurate information and increasing the fun and appeal of interactions.

By taking Mark Zuckerberg's "Horizon Worlds" as a typical case, the relationship between game UI/UX design and social interaction can be further explored. In virtual social platforms like "Horizon Worlds", the design of game UI needs to consider the social influence between users. For example, utilizing social evidence, recommendations, and evaluations to enhance users' trust and engagement with the system. By integrating the principles of design psychology and environmental and social psychology, designers can comprehensively apply these concepts in game UI/UX design, creating game interfaces that are more appealing, interactive, and social, thereby further enhancing user engagement and satisfaction.

2.2. Design psychology and its related applications

Design psychology is a discipline that explores how human psychology and behavior interact with design. It encompasses various aspects such as perception, cognition, emotion, attention, and memory, aiming to help designers better understand user needs, behaviors, and preferences in order to create more attractive, usable, and sustainable design solutions[7]. Through scientific methods and empirical research, design psychology strives to provide insights into human behavior and perceptual mechanisms to guide design optimization and innovation. The design psychology principles utilized in this study primarily include Fitts' Law, serial position effect, Hick's Law, and the Gestalt principles.

2.2.1. Fitts' Law and its related applications

Fitts' Law, proposed by Paul M. Fitts, is a well-known principle in design psychology that investigates the characteristics of human movements, such as movement time, movement range, and movement accuracy[8]. It concludes that the smaller and farther the target, the more difficult the task. The law is mathematically expressed as follows: $t = a + b \log2(D/S + 1)$, where a and b are empirical parameters that depend on the specific pointing device's physical characteristics, as well as factors related to the operator and the environment. According to Fitts' Law, the size and distance of a target have a significant impact on the difficulty of an operation, indicating that smaller targets or targets placed at greater distances are more challenging to interact with.

Fitts' Law has wide-ranging applications in UI/UX design. Based on this law, the following principles can be explained: when a button has a larger area, it is easier for users to click, resulting in shorter interaction time[9]. Conversely, when the distance between the mouse cursor or finger and the button is greater, it becomes more difficult for users to click, leading to longer interaction time. Therefore, in interface design, crucial action buttons are often designed with larger sizes to ensure that users can easily locate them and make decisions quickly, thereby improving the accuracy of user clicks and interaction efficiency, ultimately enhancing the user experience in games.

The application of Fitts' Law in UI/UX design can optimize the size and placement of buttons, improving

user interaction efficiency and accuracy, thereby enhancing the user experience in metaverse social games. Designers should not only apply Fitts' Law but also integrate principles from design psychology and environmental and social psychology, considering factors such as user cognition, emotions, and social backgrounds, to create UI/UX designs that align with user needs and environmental adaptability.

2.2.2. Serial position effect and its related applications

The serial position effect is a memory phenomenon that refers to the tendency for people to better remember the items located at the beginning and end of a list compared to those in the middle[10]. In UI/UX design, the principle of serial position effect is widely applied to enhance user memory and usability.

Designers can strategically position important options and information in the interface based on the principle of the serial position effect. Placing crucial options at the beginning or end of a sequence can help users pay more attention to and remember them more easily[11]. For example, in an interface, the close option is often positioned in the top right corner rather than the middle because people are more likely to focus their attention on the peripheral areas, making it faster to locate the close option. Similarly, the shutdown option in the Windows system is placed in the bottom left corner, utilizing the serial position effect to make it easier for users to find and operate the shutdown function.

By integrating principles from design psychology and environmental and social psychology, the application of the serial position effect in UI/UX design can be further enhanced. Design psychology focuses on user cognition and behavioral characteristics and satisfies users' attention and memory needs by arranging the sequence of important options in a logical manner. Environmental and social psychology, on the other hand, considers the influence of social environments and individual factors on behavior, taking into account user habits, cultural backgrounds, and other factors to align the interface layout with user expectations and cognitive habits.

The application of the serial position effect in UI/UX design can enhance user memory and usability. By strategically positioning important options and information, designers can leverage the serial position effect to help users quickly notice and remember crucial content. In metaverse social games like Mark Zuckerberg's "Horizon World", combining principles from design psychology and environmental and social psychology, and applying the serial position effect can optimize interface layouts and improve users' perception and user experience with essential functionalities and information.

2.2.3. Hick's Law and its related applications

Hick's Law, proposed by psychologists William Edmund Hick and Ray Hyman, states that the reaction time for making a choice increases logarithmically with the number of stimulus-response choices[12,13]. According to the equation of Hick's Law, $RT = K \log2(N + 1)$, where RT represents the reaction time, K is a constant, and N is the number of possible choices.

When applying Hick's Law in UI/UX design, designers focus on simplifying the interface's selection options. Hick's Law suggests that as the number of available choices increases, users require more time to decide which option to interact with. Users need to spend time understanding each option and making a decision, which increases their time cost and error probability. Having too many options can confuse and frustrate users, leading to potential user abandonment. Therefore, reducing the number of choices in UI/UX design is necessary to lower users' decision-making costs, reduce reaction time, and minimize error probability.

Design psychology focuses on user cognition and behavioral characteristics. By reducing the number of choices, designers alleviate users' decision-making burden, thus enhancing user interaction efficiency and satisfaction. Environmental and social psychology, on the other hand, considers the influence of social

environments and individual factors on behavior. Designers can take into account user habits, cultural backgrounds, and social needs. Combining these considerations with the characteristics of "Horizon World", designers can strategically design the selection options in the interface to better align with user expectations and usage habits.

Furthermore, the application of Hick's Law is closely related to user cognition and social psychological factors. By simplifying the interface and reducing the number of choices, designers can help users better understand and remember the functions and operation methods of the interface, thus reducing users' cognitive load. This facilitates users in mastering the usage rules of the interface more easily, enhancing their sense of participation and confidence in the game's social features, thereby promoting positive social experiences and enjoyment.

The application of Hick's Law in UI/UX design can reduce users' reaction time, error probability, and decision-making costs. By reducing the number of choices and simplifying the interface, designers can enhance user interaction efficiency and satisfaction, creating interface designs that better meet user needs and environmental adaptability. Additionally, by integrating principles from design psychology and environmental and social psychology, designers can better understand user cognition and behavioral characteristics, as well as the influence of social environments, optimizing UI/UX design and providing a better user experience.

2.2.4. Gestalt Law and its related applications

In the UI/UX design of metaverse social games, the application of Gestalt Law is also highly significant. The Gestalt Law states that when objects are visually close together, people perceive them as being related[14]. In UI/UX design, designers often avoid placing two completely opposite options together to reduce the possibility of user selection errors and enhance the user experience.

By applying the Gestalt Law, designers can use grouping lines or dividers to visually separate different options on the screen, categorizing related options together and providing a clear interface structure. For example, in "Horizon World", designers can place social features, game settings, and personal profiles in different sections, using lines or background colors to visually separate them, enabling users to quickly identify and locate the desired functions.

Furthermore, the application of Gestalt Law combines principles from design psychology and environmental and social psychology. Through well-organized layouts and organization, designers can provide intuitive and easily understandable interfaces that help users quickly browse and comprehend the available options. This aids in reducing users' cognitive load and enhances their operational efficiency and satisfaction.

By applying the Gestalt Law in the UI/UX design of metaverse social games, designers can reduce user selection errors and confusion through separation and categorization, thereby improving the usability and comprehensibility of the interface. Such design combines principles from design psychology and environmental and social psychology, providing users with a more intuitive, clear, and comfortable interactive experience that aligns with the goals of social games like Mark Zuckerberg's "Horizon World".

2.3. Environmental and social psychology and its applications

Environmental and social psychology is a discipline that studies the interactions between individuals, the environment, and social factors. It explores the psychological processes, behaviors, and experiences of humans in specific environments, as well as the influence of the environment on human behavior and psychology. Environmental and social psychology focuses on the interaction between environmental factors (such as physical and social environments) and individual psychological processes and behaviors. It aims to reveal the impact of the environment on human decision-making, attitudes, emotions, sense of belonging, and more.

Topics include environmental psychology (such as spatial cognition, environmental assessment), social cognition (such as social perception, social memory), environmental behavior (such as environmental behavior intention, energy-saving behavior), and group dynamics (such as cooperation and competition, collective behavior). In this study, the specific applications of environmental and social psychology include social identity, conformity to social norms, social influence, group decision-making, and sense of virtual presence.

2.3.1. Social identity

Social identity has significant application value in the UI/UX design of social games, particularly in building communities and group awareness and promoting social interactions. Its characteristics mainly include the following aspects:

First, social identity suggests that people tend to seek out groups that align with their own identity[15,16]. In UI/UX design, this theory can be utilized to create virtual spaces for communities and groups, allowing users to find social groups that align with their own identities.

Second, social identity emphasizes individuals' identification with and sense of belonging to a group[17,18]. In UI/UX design, providing personalized interface options, decorations, and expressions can enable users to express their personalities and identities. Third, social identity suggests that the association with a group can shape self-identity[错误!未定义书签。]. In UI/UX design, this theory can be used to encourage users to engage in social interactions and establish connections and relationships with other players.

2.3.2. Conformity to social norms

Conformity to social norms refers to the tendency of individuals to adhere to commonly accepted behavioral guidelines and norms within a social group[19,20]. In UI interaction design, designers can leverage this principle to guide user behavior and decisions, encouraging them to conform to social norms.

Through guided cues and prompts in interface design, designers communicate their expectations for specific behaviors to users, helping them adapt to the system's usage patterns and align with other users. For example, in social media applications, designers guide new users to engage in social activities and adhere to social etiquette and norms by showcasing the behaviors and interactions of other users. Features like "liking", commenting, and sharing encourage user interaction and participation, as these actions align with the social norms of social media platforms.

By integrating the concept of conformity to social norms into UI interaction design, drawing from principles of both design psychology and environmental and social psychology, designers can effectively guide user behavior, promote social interaction, and create a more social and community-oriented user experience.

2.3.3. Social influence

People are often influenced by the behavior and opinions of others when making decisions[21,22]. In UI interaction design, designers cleverly leverage principles from design psychology and environmental and social psychology to enhance user trust and engagement through social proof, recommendation systems, and feedback mechanisms, thereby improving the user experience.

The application of social influence effectively enhances user trust and engagement in "Horizon World". By utilizing social proof, recommendation systems, and feedback mechanisms, "Horizon World" creates an environment with social influence, enhancing users' social experience and satisfaction. This design approach aligns with the goals of "Horizon World" envisioned by Zuckerberg, creating an immersive and highly interactive metaverse social game.

2.3.4. Group decision making

Group decision making refers to the process of negotiation and decision-making among group members regarding common tasks or issues[23]. In UI/UX design, the principles of group decision making can be utilized to encourage user participation in collaboration, sharing opinions, and collective decision making, such as through group discussion features or collaborative editing functionalities.

The application of group decision making can enhance user engagement and the quality of social interaction in "Horizon World". Through features like group discussions, collaborative editing, and collective decision making, "Horizon World" creates a social environment where users can actively participate and make decisions together. This design approach aligns with the goals of "Horizon World" envisioned by Zuckerberg, creating a truly interactive and collaborative metaverse social game.

2.3.5. Sense of presence

Sense of presence refers to the user's perception and experience of oneself and the surrounding elements in a virtual environment[24,25]. One psychological principle relevant to this concept is "embodiment-physical consistency", which suggests that users are more likely to experience a strong sense of presence when the sensory information in the virtual environment, such as visual, auditory, and tactile cues, aligns with their actual sensations[26].

The integrated application of design psychology, environmental psychology, and social psychology is of significant importance in virtual reality (VR) interface design. One key concept is the sense of presence, which refers to the user's perception and experience of oneself and the surrounding elements in a virtual environment. To enhance the sense of presence, we can draw upon the psychological principle of "embodiment-physical consistency". This principle emphasizes the alignment between the sensory information in the virtual environment and the user's actual sensations to facilitate a stronger sense of presence.

By combining these principles with design psychology and environmental and social psychology, valuable guidance can be provided for VR interface design. In the virtual world, designers need to consider users' psychological needs, behavioral patterns, as well as the influence of the environment and social factors on users. By comprehensively applying these principles, designers can create virtual experiences that align with users' expectations and real-world perceptions, thereby enhancing the users' sense of presence and immersion. Examples of such integrated applications can be found in Zuckerberg's "Horizon World".

The integration of design psychology, environmental and social psychology, and the principles of sense of presence can offer valuable guidance for VR interface design. By focusing on user perception and experience and creating virtual experiences that align with user expectations, designers can provide high-quality, immersive, and satisfying virtual reality interactions.

3. Analysis of Mark Zuckerberg's "Horizon Worlds"

3.1. Explanation for case selection

Mark Zuckerberg's "Horizon Worlds" is an integrated world-building system developed by Meta (formerly known as Facebook)[27]. It is a free-to-play social game set in a metaverse. Within "Horizon Worlds", a virtual world is created where players can enjoy unrestricted virtual lives while adhering to the laws and rules of the virtual world. The UI interaction design aims to provide a seamless gaming experience and an intuitive user interface. This game is one of Meta's open VR social platforms in the metaverse and is envisioned to integrate gaming, work, socializing, education, fitness, and more. VR will be incorporated into a universal computing platform in the metaverse, similar to how smartphones and laptops are utilized today. The main

features of "Horizon Worlds" are as follows:

First, "Horizon Worlds" employs a holographic virtual interface that presents highly realistic game scenes, allowing players to immerse themselves in the game world and experience a sense of presence. Second, "Horizon Worlds" provides customizable profile information and social features, allowing players to quickly find friends and engage in convenient communication and interaction. Third, "Horizon Worlds" offers various interaction methods, including voice chat, gesture controls, and item exchanges. Players can choose suitable interaction methods based on their preferences and needs. Fourth, "Horizon Worlds" incorporates an intelligent navigation system, enabling players to easily discover interesting locations, tasks, and other content, thereby enhancing their exploration of the game world. Fifth, "Horizon Worlds" offers a wide range of engaging game content, including missions, challenges, PvP competitions, and more. Players can choose different gameplay styles based on their interests. Overall, Mark Zuckerberg's "Horizon Worlds" attracts a large player base by providing a smooth and intuitive gaming experience through excellent UI interaction design. It represents a new exploration in metaverse social gaming.

The main reasons for selecting Mark Zuckerberg's "Horizon Worlds" as the analyzed case are as follows: First, "Horizon Worlds" is representative among metaverse games, featuring a large scale and high user engagement. It is a metaverse experience within a large-scale social game, initiated and led by Facebook's founder, Mark Zuckerberg. The game has a broad user base and significant social impact, making it an ideal subject for studying the design principles and practices of metaverse social games. Second, "Horizon Worlds" prioritizes user experience in its design, making it both representative and analytically valuable for UI/UX Design. Zuckerberg's vision for metaverse gaming is centered around providing interactive and social virtual experiences for users. The design of "Horizon Worlds" often focuses on user engagement and social interaction, making it an interesting case for understanding the application of environmental psychology and social psychology principles in metaverse UI interaction design. Additionally, "Horizon Worlds" represents a new exploration and endeavor in metaverse social gaming UI interaction design. As a relatively novel field, UI interaction design for metaverse social games requires continuous exploration and innovation. Researching the design and user feedback of "Horizon Worlds" can uncover the connections between metaverse environments, social interactions, and user experiences, providing valuable insights for this field's design practices. Lastly, the founder of "Horizon Worlds", Mark Zuckerberg, himself has a profound influence in the industry. As a prominent figure in the technology and social media sectors, Zuckerberg's impact on the development of the metaverse and virtual reality is far-reaching. Studying his involvement in the "Horizon Worlds" project can provide industry-leading insights and best practices regarding metaverse social game design. In summary, the main reasons for selecting Mark Zuckerberg's "Horizon Worlds" as the analyzed case include its scale and influence, high user engagement, innovativeness and exploratory nature, as well as the leading position of its creator in the industry. These factors make the game a valuable case for understanding the principles of environmental psychology and social psychology in metaverse social game UI interaction design.

3.2. Collection and compilation of case evidence

The collection of evidence for the case of "Horizon Worlds" primarily involves three methods. Firstly, researching relevant literature. This includes reviewing official documents, news reports, professional articles, and academic papers related to "Horizon Worlds" to understand the background, features of the game, and Mark Zuckerberg's role and decision-making in its development. Secondly, participating in the game experience. As a player, actively engaging in Mark Zuckerberg's "Horizon Worlds" game to gain in-depth understanding of its UI interaction design and social features. Exploring various functionalities, interface operations, and social interactions, while paying attention to personal experiences and observations during the gameplay. Thirdly, gathering video and screenshot materials. Searching for game demonstration videos,

official screenshots, and recordings of relevant speeches or exhibitions associated with "Horizon Worlds". These materials can provide visual evidence and be utilized for detailed analysis of the game's interfaces and functionalities.

3.2.1. Case analysis: Leveraging environmental psychology in Horizon Worlds' design features

It is evident that Horizon Worlds harnesses visual elements, auditory effects, and interactive feedback to cultivate emotional bonds and social networks for users within its virtual realm. The design elements of its scenes can directly sway users' emotions and behaviors. Take, for instance, the garden meditation scene: set in a dimly lit nocturnal ambiance, the focal point is an illuminated fountain at the center. Surrounding the fountain are glowing trees and stone stools, all underpinned by ambient music. From an environmental psychology perspective, the centralized light source naturally draws users in, offering feelings of safety, relaxation, and pleasure. The dim surroundings of the night-time scene guide the user's emotions, conveying a sense of serenity, mystique, and ethereality.

Furthermore, different colors elicit varied emotional responses. Trees around the fountain emit hues of purple and green. These cooler shades tend to evoke feelings of calm and tranquility. Purple and green, being complementary colors, create a high contrast that can enhance focus.

Space in Horizon Worlds is also thoughtfully organized to foster spaciousness. Reflecting again on the garden meditation setting, the spread-out layout ensures users feel a sense of freedom and ease. The music and soundscapes in the garden augment the emotional experience. Users also have the liberty to control the music tracks and view song details from a console beside the fountain, tailoring their auditory experience to their preferences.

In sum, the developers and designers have meticulously crafted the lighting, color palette, object placement, and sound design in Horizon Worlds to shape the user's emotional journey within each scene. Such deliberate design elements are tools to steer emotions and behaviors, thereby amplifying the game's immersive appeal and allure.

3.2.2. Case study: The interplay of environmental psychology and user experience in Horizon World's virtual interaction design

In Horizon World, users can modify their virtual avatars and the surrounding environment through an integrated editor within the game. This tool offers users a wide array of aesthetic choices, from physical features such as hairstyles, attire, and skin tones, to broader environmental elements like terrains, fauna, flora, and cultural landmarks. Presented in intuitive iconography, users find making their selections effortless. Furthermore, as adjustments to the avatar are displayed in real-time, immediate feedback is provided, thereby encouraging users to personalize their virtual identities. By offering extensive customization options, Horizon World effectively allows users to forge a personal connection to their virtual selves.

Moreover, within Horizon World, users can teleport in real-time to various locations via an activity interface and interact with other participants through both verbal and non-verbal communication. For instance, by tapping on a virtual wristwatch, users can be instantly transported into an ongoing event. Non-verbal gestures like smiling, waving, nodding, shaking hands, or cheering are executed either by selecting virtual buttons or manipulating motion controllers. Additionally, the platform permits text and voice chat, with interfaces designed for simplicity and user-friendliness to foster real-time conversations.

From the lens of environmental psychology, Horizon World's clarity in graphic interface coupled with its straightforward controls ensures user-friendliness, eliminating the need for intricate system tutorials. Much of this ease is attributed to its advanced 3D motion capture technology and handheld motion controllers, enabling

users to harness the game's world-building system for their virtual creations. Furthermore, Horizon World thoughtfully provides operation manuals and tiered tutorials, significantly reducing barriers for users to dive into the game and engage in social interactions. Real-time interactions and feedback allow users to comprehend how their actions reverberate within their virtual avatars and amongst peers. This form of feedback bolsters users' social confidence and satisfaction, spurring positive interactions. Moreover, the freedom to personalize one's avatar and environment is a testament to self-expression, granting every user a distinctive footprint in this virtual universe. This facilitates the birth of an inclusive and congenial social environment where users find a sense of belonging in a diverse community.

In essence, Horizon World's intuitive avatar editor and social interaction interface serve to reduce complexity, furnish real-time feedback, and champion individualism, driving users towards engaging in social interactions within a secure and welcoming virtual domain. These design elements assist users in effortlessly forging connections, sharing experiences, and reveling in the game with fellow users.

3.2.3. Case study: Leveraging environmental psychology in "Wing Strikers" to boost user engagement and loyalty in Horizon World

"Wing Strikers" is a playable multiplayer game within Horizon World, where players navigate by manually piloting an aircraft, demanding collaboration with others to delve deeper into the in-game universe[28]. Players deftly maneuver their aircrafts, diving and ascending within an expansive arena, seizing missiles and other tools as offensive mechanisms to gain an edge in competitions. Evidently, grabbing these missiles and tools delivers instant positive feedback, empowering players to counter adversaries or secure strategic positions more efficiently. Emerging victorious in team-based challenges, such as the capture-the-flag events, bestows players with coveted titles of honor.

Moreover, piloting through the vast arena or world satiates players' innate desire for exploration, especially when the environment is intricately crafted, teeming with concealed secrets and rewards, significantly amplifying the overall allure. Since it's a multiplayer game, inter-player interactions and rivalries considerably heighten player immersion. There's an inherent emphasis on teaming up with friends, forming alliances with other users, and embarking on collective endeavors. This teamwork not only fulfills social needs but can also instill a profound sense of accomplishment when collaboration yields success.

In essence, "Wing Strikers" adeptly utilizes principles from environmental psychology in its game design, enriching the user experience with elements of challenge, reward, exploration, and social interactions. These intricacies work in tandem to escalate player immersion, engagement, and loyalty within the Horizon World.

3.3. Analysis of technological application in the case

The UI/UX design of "Horizon Worlds" integrates principles from design psychology and environmental and social psychology, resulting in a virtual world game with superior UI interaction design. In this game, designers consider users' cognitive needs, behavioral patterns, as well as environmental and social factors to create an interactive interface that is engaging and aligns with user expectations.

3.3.1. Analysis of design psychology principles

By applying design psychology principles, the interface can maintain simplicity and coherence. Only essential options are displayed, minimizing excessive textual information and reducing cognitive load. Through the use of intuitive and easily understandable icon designs, players can quickly grasp the purpose of each option. This design approach allows players to swiftly locate desired options and enhances their user experience when entering the game and interacting with the virtual world. The influence of design psychology principles on UI interaction design in metaverse social games encompasses the following four aspects.

The first aspect is the crucial application of Fitts' Law in UI interaction design of metaverse social games. Designers can utilize Fitts' Law to design important functional buttons with larger sizes, making them more prominent within the interface and enabling users to identify and click on them quickly. By strategically placing buttons in accessible positions, users can easily reach and operate them, reducing interaction time and enhancing their gaming experience. Additionally, considerations should be given to specific device characteristics, user interaction habits, and environmental factors, ensuring that the size and placement of buttons align with users' operational needs and expectations. Taking Mark Zuckerberg's "Horizon Worlds" as an example, in metaverse social games, this means designers can enhance users' experience with social functionalities by optimizing button size and placement. For instance, designers can position significant social buttons such as "Add Friend", "Private Chat", or "Group" in easily identifiable and clickable locations, enabling users to initiate social interactions swiftly and enhancing the convenience and fluidity of social interactions.

The second aspect involves the significant role of the serial position effect in UI interaction design related to "Horizon Worlds". Designers can place important functions or information at the beginning or end of the interface, making them more noticeable and memorable to users based on their needs and interface characteristics. For example, in "Horizon Worlds", social interaction is a core feature, and designers can position social functions such as "Add Friend" and "Chat" in prominent locations, such as the top or bottom of the interface, utilizing the serial position effect to improve users' perception and frequency of using these functionalities.

The application of Hick's Law is closely related to enhancing the social experience in UI interaction design of metaverse social games. By simplifying options within the interface, designers can reduce the choices users need to make during the interaction process, thereby reducing decision-making burden and cognitive load. This design approach helps users navigate and use the interface more effortlessly, providing a smoother and more intuitive user experience. Additionally, social experience is crucial in social games as users desire interaction and communication with other players. By applying Hick's Law principles, designers can place core social functionalities and operations in prominent positions, making them more noticeable and accessible to users. For instance, in "Horizon Worlds", designers can place social functions (such as "Add Friend", "Private Chat", "Team Up", etc.) in prominent locations within the navigation menu, allowing users to quickly locate and perform actions, thus enhancing the convenience and efficiency of social interactions.

The fourth aspect involves the application of the Gestalt principle in metaverse social games like "Horizon Worlds", which improves the usability and comprehensibility of user interfaces by providing clear option layouts and organizational structures. By avoiding the placement of conflicting options together, designers can reduce the likelihood of user errors and minimize confusion and hesitation, thereby enhancing users' trust and sense of control over the interface. Such design helps elevate the user experience, enabling users to navigate social game interfaces more effortlessly and enjoy a smoother and more pleasant interaction process.

3.3.2. Analysis of environmental and social psychology principles

Taking into account the influence of environmental and social psychology, designers pay attention to the user's environment and social context. The UI/UX design features a responsive layout to adapt to different screen sizes and interaction methods, providing a flexible and convenient interactive experience across different devices and environments. Additionally, considering the user's social interaction needs, the game incorporates social functionalities and user feedback mechanisms, enhancing the user's sense of participation and belonging. Specifically, the impact of environmental and social psychology can be analyzed in the following five aspects.

Firstly, social identity plays an irreplaceable role in the UI interaction design of metaverse social games. Firstly, by providing personalized group identification, symbols, and interface elements, "Horizon Worlds" helps users establish a sense of community identity and stimulates their willingness to engage in social interactions. Secondly, "Horizon Worlds" offers various customization options, allowing users to shape their own image, style, and personal taste in the game, thereby enhancing their sense of community identification and participation. Lastly, "Horizon Worlds" provides social functionalities and tools such as friend lists, group chat, and multiplayer games, enabling users to interact with groups they identify with, share interests, experiences, and ideas, and enhance the social experience. In summary, social identity in UI/UX design of social games can be used to build community and group awareness, promote social interaction, and provide opportunities for personalization and self-expression. By applying principles from design psychology and environmental and social psychology, "Horizon Worlds" can create a virtual environment with social identification, allowing users to find groups that align with their identity and shape their self-identity through social interactions, thus enhancing the quality of the social experience.

Secondly, in games like "Horizon Worlds" by Mark Zuckerberg, designers utilize principles of conformity to social norms to enhance user engagement and social experience. By setting social rules within the game and encouraging users to follow group behavior guidelines such as cooperation, resource sharing, and mutual assistance, a positive social environment is created, leading to increased user engagement and satisfaction.

Thirdly, within the context of "Horizon Worlds" and similar metaverse social games, the application of social influence is particularly prominent and important. As a metaverse social game, "Horizon Worlds" aims to provide a virtual social platform. Designers utilize principles of social influence to enhance user trust and engagement with the system, thereby enhancing the social experience. On one hand, "Horizon Worlds" employs social proof to shape user expectations and decisions. By showcasing positive behaviors, social interactions, and achievements of other players within the game, designers stimulate users' enthusiasm for participation and a sense of belonging. Such social proof allows users to experience the positive actions of other players and encourages them to actively engage in social activities within the game. On the other hand, recommendation systems play a significant role in "Horizon Worlds". By analyzing user preferences and behavior, personalized game content, social connections, and activities are recommended to users. These recommendations are based on the choices and feedback of other players, as well as intelligent algorithms, guiding user behavior and decisions and increasing their engagement with the game. Additionally, "Horizon Worlds" leverages user evaluations and feedback to establish social trust and engagement. By displaying positive reviews, high ratings, or positive feedback from other players, designers enhance users' trust in the system, making them more willing to participate in social interactions and cooperative activities within the game. Such social feedback and evaluations provide users with references, shaping their perception of "Horizon Worlds" and motivating them to participate more actively.

Fourthly, in the context of "Horizon Worlds" and similar metaverse social games, the application of collective decision-making can enhance user participation and the quality of social interaction. "Horizon Worlds", as a metaverse social game, employs principles of collective decision-making to stimulate user collaboration and collective decision-making abilities, thus enhancing the social experience. Firstly, "Horizon Worlds" provides group discussion features that encourage users to engage in negotiations and discussions on common tasks or issues. By creating groups, joining communities, or participating in team activities, users can discuss strategies, share opinions, and make decisions with other players. This group discussion feature promotes interaction and collaboration among users, enhancing the social experience and the game's playability. Secondly, "Horizon Worlds" offers collaborative editing features that allow multiple users to participate in creating and editing game content. By enabling users to collectively design terrains, buildings,

missions, etc., "Horizon Worlds" stimulates users' creativity and cooperative spirit. This collaborative editing feature not only increases user participation and autonomy but also strengthens awareness of social interaction and teamwork. Lastly, "Horizon Worlds" shapes the development and evolution of the game through collective decision-making. For example, by conducting user voting, gathering opinions, or community feedback activities, "Horizon Worlds" involves users in the decision-making process, collectively determining the future direction and feature updates of the game. Such forms of collective decision-making enhance user accountability and engagement while providing a sense of identity in co-creating the game world.

Fifthly, as a virtual social platform, "Horizon Worlds" needs to facilitate user interaction with the virtual world through interface and interaction design. Designers can utilize the principle of presence to ensure that sensory information in the virtual environment, such as visuals, sounds, and touch, is consistent with users' actual sensations, thereby enhancing the user's experience of "Horizon Worlds". Additionally, considering users' social needs, designers can apply principles from design psychology and social psychology to create more attractive, interactive, and social-oriented interfaces, thereby enhancing user engagement and satisfaction.

By comprehensively applying principles from design psychology and environmental and social psychology through UI interaction design, players can better immerse themselves in the virtual world. The layout and size of the interface follow ergonomic design principles, providing a comfortable visual experience. The placement and grouping of important options enable players to quickly remember and access them. These design decisions allow players to obtain a more realistic and seamless interactive experience in the game.

Through the analysis of "Horizon Worlds" as an example, we can see the importance of design psychology and environmental and social psychology in UI interaction design. By effectively applying principles from these two fields, designers can create interfaces that better align with user needs and expectations, thereby enhancing user participation, satisfaction, and immersion.

4. Conclusion and implications

4.1. Conclusions

The comprehensive application of design psychology and environmental and social psychology in game UI interaction design is crucial for creating a high-quality user experience. By considering players' cognitive needs, behavior patterns, and environmental and social factors, designers can create interactive interfaces that are engaging and align with user expectations, thereby enhancing player immersion and engagement.

In game UI/UX design, well-designed interfaces are key. By using a clean and logical layout and intuitive icon design, cognitive load can be reduced, and interactive options can be presented in a clear and understandable manner, thus minimizing users' cognitive burden and operational difficulties, ultimately improving the user experience.

Additionally, considering the influence of environmental and social psychology is also necessary. A responsive layout in the game UI interface can adapt to different screen sizes and interaction methods, providing a flexible and convenient interactive experience. By incorporating social features and user feedback mechanisms, user interaction and social engagement can be promoted, enhancing the user's sense of participation and belonging.

By applying principles from design psychology and environmental and social psychology, game designers can create interfaces that better meet user needs and expectations, thereby enhancing user engagement, satisfaction, and immersion. Through the analysis using "Horizon Worlds" as an example, we have observed the effectiveness of this comprehensive application in real games, providing users with a high-quality UI interaction experience that allows players to better immerse themselves in the virtual world.

Therefore, incorporating the comprehensive application of design psychology and environmental and social psychology into the process of game UI interaction design can contribute to enhancing the user experience, increasing player engagement and satisfaction, and making a positive contribution to the successful development of games.

4.2. Implications

4.2.1. Theoretical contributions

This study holds significant importance in advancing research related to metaverse social games. By integrating design psychology and environmental and social psychology, this research explores the unique factors in metaverse social games and provides guidance for designers, aiming to gain a deep understanding of user needs and create metaverse social game interfaces that better meet user requirements and social adaptability.

Firstly, it integrates the principles of design psychology and environmental and social psychology involved in the UI/UX design of metaverse social games, summarizing the research progress in UI/UX design of metaverse social games, with "Horizon Worlds" as a representative. Design psychology and environmental and social psychology are two independent but related fields. By unifying them, this study provides a comprehensive research perspective for UI interaction design in metaverse social games. This comprehensive approach contributes to a deeper understanding of the impact of user cognition, emotional needs, and environmental and social factors on user behavior and psychological states.

Secondly, this study delves into the various influencing factors in UI/UX design of metaverse social games. As a virtual global social platform, the metaverse possesses unique environmental and social psychological factors, such as users' social needs, identity expression, and personal interactions. This research reveals the impact of these specific factors on UI interaction design and explores how to utilize the principles of design psychology and environmental and social psychology to meet user needs, thereby facilitating the creation of an authentic and immersive virtual social experience.

Furthermore, through in-depth analysis of the UI interaction design in Mark Zuckerberg's "Horizon Worlds", this study provides designers with deeper insights and guidance. It explores how to use visual elements, sound effects, and interactive feedback to guide players in establishing emotional connections and social networks in the virtual world, focusing on aspects such as interface usability, personalization, social interaction, and emotional connection. This not only helps expand the theoretical foundation of UI interaction design in metaverse social games but also provides empirical research cases and references for the application of environmental and social psychology in the field of game interface design, enriching the knowledge system of UI interaction design in metaverse social games.

4.2.2. Practical significance

This study has several key practical implications. Firstly, it deepens the understanding of users' cognitive and emotional needs in the context of metaverse social games. By applying principles of design psychology, we can better understand why users prefer certain UI interaction interfaces and how they engage with them. This understanding can be further utilized to design more user-friendly UIs, thereby enhancing user experience, product acceptance, and user satisfaction.

Secondly, this research, through the principles of environmental and social psychology, enhances our understanding of the impact of environmental and social factors on user behavior and psychological states. In the social gaming environment of the metaverse, these factors may have significant influences on user choices and behaviors. This understanding can assist designers in better meeting users' social needs and providing

higher satisfaction through personalized and customized solutions.

Furthermore, taking "Horizon World" by Zuckerberg as an example, the findings of this study provide valuable reference materials for the practical application of theories in real gaming projects. The process of turning theory into practice can visually demonstrate the application of design psychology principles and environmental and social psychology principles in UI interaction design of metaverse social games. This approach will offer more intuitive design recommendations and facilitate designers' understanding and application compared to traditional theoretical descriptions.

This study serves as an effective empirical research case that broadens the theoretical foundation of UI interaction design in metaverse social games and opens up a new design perspective for designers. It proposes the idea of providing socially adaptive interface designs that combine environmental and social psychological principles with user needs.

4.3. Limitations and prospects

There are some limitations in this study. On one hand, although this study explores the principles of design psychology and environmental and social psychology in UI interaction design of metaverse social games from both theoretical and empirical perspectives, the empirical case of "Horizon World" represents only one type of metaverse social game, limiting the generalizability of this research. On the other hand, given the characteristics and nature of the metaverse, users' social and cultural backgrounds are important factors influencing their gaming experiences. However, this study did not extensively analyze specific design needs for users from different social and cultural backgrounds.

To address the aforementioned limitations, future research can expand the sample scope and explore other types of metaverse social games, such as adventure games, role-playing games, etc., to gain a broader understanding and insights into UI design. Additionally, future studies can focus on how to design game interfaces that better cater to the specific needs of users from different cultural and social backgrounds, and how to incorporate social and cultural diversity and inclusivity in the design process, thereby advancing the development of UI interaction design, gaming, academic research, and other multidisciplinary domains.

Author contributions

Conceptualization, BG; methodology, BG; software, BG, HX and YW; validation, BG, HX and YW; formal analysis, BG, HX; investigation, BG, HX and YW; resources, BG, HX and YW; data curation, BG, HX and YW; writing—original draft preparation, BG, HX, YW and ZX; writing—review and editing, BG, HX, YW and ZX; visualization, BG, HX, YW and ZX; supervision, BG; project administration, BG; funding acquisition, BG. All authors have read and agreed to the published version of the manuscript.

Acknowledgments

This work was supported by Jiangxi Provincial University Humanities and Social Sciences Research Project [grant number GL22223]. This work was also supported by the Science and Technology Research Project of the Jiangxi Provincial Department of Education [grant number GJJ2200517].

Conflict of interest

The authors declare no conflict of interest.

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