



Player Fatigue Caused by Visual and Motion Design in High-Immersion VR Games and Optimization Strategies

Haoge Yan¹ and Mingjie Zhang^{2*}

¹ Shenzhen Art High School, Shenzhen, 518035, China

² International Department of Xuzhou No.1 middle school, Xuzhou, 221000, China

*zhangmingjie6666@outlook.com

Abstract. With the gradual popularization of virtual reality technology, high immersion VR games have become an important development direction of the game industry with a strong sense of substitution. The physiological and cognitive fatigue caused by long-time experience of players has become an important constraint to the sustainable development of the industry. This paper selects three representative highly immersive VR works of black Myth: Monkey King VR version, horizon: Call of the mountains and biochemical crisis 4 VR version as the research object, and uses the case analysis method to analyze their advantages and disadvantages from two aspects of visual presentation design and role sports design, so as to explore the mechanism of relevant design on players' physiological reactions such as visual acid, dizziness and cognitive states such as attention exhaustion and mental burnout. The research shows that high-precision picture rendering, strong light contrast, lack of buffer in motion transition, and lack of rationality in perspective arrangement are the key inducements to induce players' fatigue. The fatigue effects of games with different themes on the design of short boards show obvious differences. Therefore, according to the above research conclusion, integrating the existing relevant academic achievements, the optimization path of VR game design is systematically summarized

Keywords: VR, visual design, sports design, fatigue analysis

1 Introduction

Virtual reality (VR) technology continues to rapidly iterate and gradually popularize. High immersion VR games have become an emerging hot field in the game industry. Relying on immersive experience, three-dimensional scene and interactive operation mode, it breaks through the visual and experience boundary of traditional games and has been widely recognized and loved by the majority of players. The launch of mainstream works such as the VR version of black Myth: Monkey King, horizon: the call of the mountains, and the VR version of biochemical crisis 4 has further promoted the market-oriented development of high immersion VR games and become the most representative type of VR games at present. Behind the high immersion experience, physiological and cognitive fatigue problems such as visual acid swelling, dizziness, attention exhaustion and so on, which occur in the process of long-term play, have

gradually become the key bottleneck restricting the sustainable development of VR games, not only affecting the game experience and physical and mental health of players, but also limiting the popularity and promotion of high immersion VR games. It is of great theoretical significance and practical value to explore the impact of the design characteristics of high immersion VR games on player fatigue, sort out the advantages and disadvantages of game design, and put forward targeted optimization ideas for improving VR game experience and promoting the healthy development of VR game industry. At present, scholars at home and abroad have carried out relevant research on the relationship between VR games and player fatigue, and formed a series of research results. Research has confirmed that the high detail rendering, light stimulation and continuous motion design of VR devices are the core factors that cause players' visual fatigue and dizziness. At the same time, the first person perspective will significantly aggravate the fatigue induction effect [1]. Other studies have clearly shown that high detail rendering, strong light contrast and other visual designs will increase the adjustment load of players' ciliary muscles, further revealing the internal relationship between visual design and visual fatigue [2]. Other studies have found that rapid movement without buffer is easy to cause VR motion sickness, and there are significant differences in the effects of different perspectives and interaction modes on the cognitive load and fatigue of players [3]. Low brightness and high contrast visual environment will increase the burden on players' eyes, while negative emotions will further aggravate cognitive fatigue [4]. An overview of the existing research results shows that the academic community has made clear the correlation between VR game design and player fatigue. Therefore, most of the existing studies lack specific case analysis for mainstream high immersion VR games, and do not fully combine the advantages and disadvantages of the game design to carry out targeted research, leading to the improvement of the practicality of the research conclusion. Based on the above research background and existing literature, this paper takes three representative high-immersion VR games as research objects, uses the case analysis method to compare and analyze their visual design, motion design and perspective arrangement, and explores the specific mechanism of these design factors on players' physiological and cognitive fatigue. Furthermore, this paper summarizes the common problems and differential characteristics of fatigue induction in different types of VR games, and finally puts forward targeted optimization paths and future research prospects for low-fatigue design of high-immersion VR games, so as to provide practical reference for improving player experience and promoting the healthy development of the VR game industry.

2 Research Scope and Methods

2.1 Scope

Three highly immersive VR games with industry representativeness and different perspectives are selected as the research object, covering two core categories: action adventure and open world. Both of them have the core characteristics of high visual fidelity and continuous motion interaction, which are in line with the current

mainstream development trend of highly immersive VR games. The selected games are benchmark works with high market attention and a large number of players. Among them, the action adventure category is represented by the VR version of black Myth: Monkey King, and the open world category is represented by horizon: the call of the mountains. At the same time, the VR version of biological crisis 4, a terrorist survival category, is supplemented with rich research dimensions to ensure the diversity and representativeness of research objects. Combined with the existing research on the definition standard of high immersion VR games [1], the selected Games meet the three core conditions of immersive scene construction, interactive operation experience and high detail visual presentation, which can effectively reflect the common and differential characteristics of current high immersion VR Games' design, and provide a reliable research carrier for exploring the relationship between game design and player fatigue.

2.2 Methods

The case analysis method was clearly and appropriately used in this study, because this method is particularly suitable for the disassembly and analysis of specific research objects, so as to naturally and fully mine the characteristics and internal relationship of research objects, so it is also one of the most common, mature and reliable research methods in VR game research [3]. Therefore, this paper first disassembles the design logic of the three selected games from three dimensions of visual design, motion mode and perspective type: the visual design part examines the elements of picture details, rendering accuracy and light and shadow effects; the motion mode part discusses the displacement mode, interaction logic and motion buffer design; the Perspective type part compares the actual impact of different perspective designs on the player experience. What's more difficult is that in combination with the feedback of players' actual playing experience, the existing evaluation indexes of VR game fatigue in relevant literature are cited [4], and physiological fatigue (visual acid swelling, dizziness) and cognitive fatigue (attention exhaustion, mental fatigue) are taken as the core evaluation dimensions, so as to systematically and rigorously clarify the internal relationship between the design dimensions of the game and players' fatigue.

3 Case Analysis

3.1 The VR Version of Black Mythology

Monkey King is an action adventure high immersion VR game based on classic IP. With Oriental mythology as the core theme, it restores the classic scenes and characters of journey to the west, adopts the first person perspective, supports a variety of VR operations such as head rotation, body movement, gesture interaction, and focuses on Immersive combat and exploration experience. The game has excellent pictures, rich details and cool special effects. It is a representative work of highly immersive VR games made in China. The high degree of restoration of scenes such as Huaguoshan effectively improves players' sense of immersion

The visual design has excellent advantages. The Oriental mythological elements are fully used, and the scene details are handled extremely delicately. The elements of the ancient buildings are clear and appropriate. The skill effects and mythological settings are consistent with each other. The light and shadow are natural and smooth. The picture has a strong visual impact and is never messy. The scene switching is smooth, and the style changes are consistent. Therefore, the visual aesthetic fatigue is naturally alleviated. However, it goes without saying that the game has been rendered in high detail for a long time, and the skill effects and fast-moving scenes that frequently switch during the battle will continue to occupy visual attention, so it is easy to cause the adjustment load of ciliary muscle to increase, resulting in physiological fatigue such as visual acidosis and difficulty in focusing [5]. What is more serious is that there is a great contrast between light and shade in some scenes. The switching between dark cave and strong outdoor light directly stimulates the eyes, increasing the burden, and the fatigue feeling is significantly increased after long-time play [6].

The movement mode and playing method are very natural and appropriate. The first person perspective is combined with gesture interaction. The operation feel is smooth and the sense of substitution is very strong. The movement speed can be flexibly adjusted according to the player's habits. The blinking and walking modes are in their respective positions. The movement design and rhythm in the battle scene match very skillfully, so the player will have a strong sense of participation and corresponding sense of achievement. But needless to say, there are also very clear and important problems in the design: the lack of motion buffer in flight, rapid blinking and other scenes, the players need to turn quickly and move quickly to avoid the attack during the battle, and continuous rapid movement is easy to break the body balance perception, which directly causes VR dizziness, which is also highly consistent with the research conclusion of "sensory conflict caused by uncoordinated vision and vestibular system" [7]. What is more serious is that continuous movement operation and combat response will greatly consume attention, so there may be negative effects such as inattention, slow response and reduced willingness to play [8].

3.2 Horizon: The Call of Mountains

The call of mountains is a high immersion VR game of open world adventure. With the theme of future science fiction, it is set in natural scenes such as snow capped mountains, forests, and canyons. It supports the switching of first and third person perspectives, and can perform interactive operations such as walking, climbing, gliding, and archery. It focuses on Immersive open world exploration. It is a benchmark work of this type of VR game. Its open world scene design is highly hierarchical and can effectively enhance players' interest in exploration

Visual design has obvious and prominent advantages: the open world, the distant view and close view are fully rendered, the snow texture of snow mountains and forest vegetation layers are naturally and properly depicted, the weather effects are dynamic and smooth, and they are well integrated with the scene, so the visual effect is pleasing to the eye, which is also very conducive to creating a sense of immersion. At the same time, the visual tone is comfortable, and there is no harsh color, so it can well alleviate visual fatigue. But needless to say, the scale of the open world scene is very large. When

players browse for a long time and look for targets, they must frequently switch between the distant view and the close view, and adjust the visual focus, so it is also easy to cause visual fatigue [9]. In the actual game, players' long-time exploration will lead to visual acid swelling. The problem of blurred vision in the wind and snow scene is more prominent, and the actual sense of fatigue is amplified. More seriously, some weather special effects (strong wind and snow) continue to stimulate the vision with high intensity, while the elements seen in some scenes are too similar, so it is easy to produce visual aesthetic fatigue after long-time browsing .

The movement mode is very consistent with the exploration needs. The movement mode is rich and the difficulty is moderate, so it is very easy to use, and the angle of view can be switched naturally and smoothly. Therefore, the dizziness is minimal, the movement rhythm is arranged reasonably, and the speed of exploration is gentle. Climbing, gliding and other sports are equipped with clear and appropriate buffers. Players are always in a comfortable state of play. But needless to say, the lack of sports mode also stems from the basic characteristics of open world exploration: irregular exploration will inevitably lead to players' long-term state of "looking for goals+controlling sports", which will increase the cognitive load and lead to cognitive fatigue such as attention exhaustion and fatigue. Specifically, some gliding scenes are too fast, too long and lack of rhythm buffer, so it is easy to cause vertigo, while climbing scenes require continuous control of body posture and repeated execution of the same actions, so it is easy to cause physical fatigue and aggravate cognitive fatigue.

3.3 The VR Version of Biochemical Crisis 4

The VR version of biochemical crisis 4 is a VR adaptation of the classic horror survival game. With terror suspense as the core theme, it is set in the dark castle, basement, village and other scenes. It uses the first person perspective, supports interactive operations such as gesture shooting and close combat, and focuses on Immersive terror survival experience. Its dark scenes and sudden enemy design effectively strengthen the terror atmosphere.

One of the major advantages of visual design is to create a terror suspense atmosphere with dim light, weird light and shadow changes, and exquisite scene details. Therefore, it has a strong sense of immersion. The modeling of characters and enemies is very fine, and the movement is smooth and natural. The visual details are highly consistent with the theme. The terror effect and visual beauty are well balanced, and there is no bloody and dazzling picture. But needless to say, there are also obvious problems in visual design caused by the horror theme itself: the game scenes are mostly in a dark environment, with dim light and frequent light and shadow changes, so long-term exposure to a low brightness and high contrast visual environment will produce physiological fatigue symptoms such as visual acid and blurred vision [4][10]. More importantly, the sudden enemy attack in the terrorist scene will inevitably cause players' emotional tension and indirectly aggravate cognitive fatigue. Therefore, after playing, they often feel nervous, distracted and tired.

Because the movement mode naturally matches the terrorist survival playing method, the first person perspective can perfectly express the terrorist atmosphere, so the sense of tension and stimulation are very obvious, and the operations of moving,

turning and shooting are smooth and fast, so the player can respond in time and appropriately when encountering the enemy's pursuit, with excellent playability.

From the current discussion, the paper has its shortcomings naturally and appropriately, that is, there is a direct and clear relationship between the first person perspective and the scene design: the first person coordinates with the narrow scene, so the player needs to move quickly in a narrow space, turn around and shoot, and the scene switching is very easy to cause dizziness. In some chase scenes, players have to run at high speed to avoid pursuit. Continuous high-intensity sports will inevitably add physical and psychological fatigue, so they are prone to fatigue and slow response.

4 Analysis and Discussion

4.1 Common Advantages

Due to the high sense of immersion achieved by using high visual fidelity and reasonable motion interaction, the visual angle design and game categories naturally cooperate with each other. The first person is conducive to substitution, and the third person is conducive to the balance of operation and vision.

4.2 Summary of Core Issues

Starting with visual design, the paper first clearly analyzes its high detail and high dynamic characteristics, and naturally and appropriately points out that there is no dynamic visual load adjustment for VR scenes, resulting in ciliary muscle tension and visual information overload, which is the most direct and clear cause of physiological fatigue. Then it discusses the motion mode, that is, the general design of continuous non buffered displacement will cause the deviation between visual motion and real body perception, so it is easy to cause sensory conflict and dizziness, and there is a lack of hierarchical selection of motion mode. On the difference of perspective: the fatigue inducing effect of the first person game is more obvious, because the visual stimulation is more direct and the sensory conflict is more intense, while the third person is less tired, but it does not solve the fundamental problem of motion perception bias. Finally, as for the prevention and control of fatigue, it is strictly pointed out that the three games lack effective fatigue prevention and control design, no visual buffer, no motion buffer mechanism, and do not consider the individual differences of players' fatigue tolerance.

5 Conclusion

Taking three mainstream high immersion VR games as the research object, this paper uses the case analysis method to systematically and rigorously investigate the impact of game design on players' fatigue from the dimensions of visual design, motion mode, and perspective type. From this, it naturally and appropriately concludes that high visual load and continuous non buffered exercise are the main causes of fatigue. The first person game fatigue is the highest, and the third person does not solve the core problem. Therefore, the prevention and control of heavy immersion and light fatigue is

a common problem in the industry. Therefore, in the future, people should balance immersion and fatigue prevention, optimize visual and sports design, develop personalized fatigue prevention and control functions, and supplement relevant technologies with quantitative research methods, so as to truly provide data support for low fatigue VR game design. Based on these findings, future high-immersion VR game design should prioritize fatigue prevention while maintaining immersion. In visual design, dynamic visual load adjustment technology should be introduced to automatically adjust scene detail accuracy and lighting intensity based on the player's focal point and gameplay duration. In motion design, graded motion mode options should be added, and buffering mechanisms should be improved for all fast-motion scenarios. In fatigue prevention, personalized fatigue management systems should be developed, combining eye tracking, heart rate monitoring, and other technologies to real-time monitor player fatigue and provide targeted rest reminders and intensity adjustments. Future research could expand the sample size to further explore differences in VR fatigue sensitivity across ages and experience levels. Additionally, physiological signal collection technologies such as electroencephalography (EEG) and electromyography (EMG) could be used to establish a quantitative fatigue evaluation system, providing more precise experimental data for low-fatigue VR game design. As technology advances and design concepts evolve, high-immersion VR games will better balance immersion and health, delivering superior experiences to players.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

References

1. Fan, L. and Wang, J.: Research on the impact of consumer VR equipment on users' visual fatigue. *Digital Entertainment Technology* 8(3), 45-52 (2024)
2. Shi, X. and Wang, S.: Research on the correlation between VR game visual design and user fatigue. *Game Research* 6(2), 78-85 (2025)
3. Nisiotis, L. and Elia, K.: VR game interaction mode and user experience research. *IEEE Transactions on Games* 17(4), 321-330 (2025)
4. Su, Y.: Effects of visual environment and emotion of VR games on cognitive fatigue of players. *New Media Research* 10(11), 98-105 (2024)
5. Cao, L.: Expectancy violation in virtual environments causes headaches, nausea and uncanny feelings. *Computers in Human Behavior Reports* 8(2), 101-108 (2025)
6. Holly: The causes and relief methods of motion sickness. *Ophthalmology Research* 42(9), 789-793 (2024)
7. Lin, Y.: Pathogenesis and coping strategies of 3D vertigo. *Journal of Otolaryngology Head and Neck Surgery* 32(12), 890-894 (2025)
8. Anonymous: Research on the correlation between VR game interaction design and user fatigue. *IT Research* 9(2), 45-52 (2017)
9. Cai, M.: Influencing factors and mitigation measures of visual fatigue in 3D games. *New Media Research* 11(22), 102-106 (2025)
10. Zhang, J. and Bai, J.: Analysis of the phenomenon of electronic motion sickness in Black Myth: Wukong. *Digital Entertainment Technology* 8(9), 56-62 (2024)

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

