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Influence of Gender on VR Animation Viewing Experiences: from the Perspective of Comfortable Viewing Distance

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Abstract

In recent years, we have witnessed a growing popularity of virtual reality (VR) technology. Understanding the factors that contribute to a comfortable VR viewing experience is crucial for its successful implementation. This study specifically explored the role of gender in determining the ideal viewing distance for VR animation. To do so, we enlisted 100 participants, comprising 41 males and 59 females, and had them engage in a VR animation viewing task, during which we recorded their preferred viewing distances. Our findings revealed that there was no significant distinction between males and females regarding their favored VR animation viewing distances. These results suggest that when creating VR content, gender may not be a noteworthy factor to take into account when determining the optimal viewing distances for a comfortable experience.

Keywords: *Virtual Reality，Animation，Viewing Distance，Proxemics*

1. Introduction

VR technology has become increasingly popular in recent years. It allows users to immerse themselves in computer-generated environments and experience scenes that would be impossible in the real world. VR technology is being applied in various fields such as education, healthcare, and entertainment. The advancements of VR technology in gaming, animation, and film industries have brought about new forms of viewing and better experiences. Various film and gaming companies are starting to develop new VR-based movies and games. Although VR technology is still not mature enough, the immense immersion it provides is unmatched by any other technology today.

However, despite the widespread use of VR technology, there are still many issues that need to be addressed, notably in the animation field. Because the 3D VR animation is vastly different from traditional animation in production and viewing methods, issues like how to improve user experiences and enhance immersion need to be studied and resolved. One of the key factors in improving user experiences is the comfortable viewing distance in VR. The production methods for 3D VR animation and traditional 3D animation differ significantly. While traditional 3D animation obtains the final animation by rendering a sequence of images, currently there are two methods for producing 3D VR animation [1]. One method involves building an animated scene in 3D software and rendering a sequence of 360-degree images, which are then composed into a 360-degree VR animation; the other involves building an animated scene in a game engine and using real-time rendering to

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generate the final VR animation [2]. Different production processes bring different visual perceptions.

In order to accurately convey the story content and the director's ideas, the position of the camera is essentially fixed in VR animation. Although the audience watches the animation from a fixed position, they can still rotate their heads and freely change their perspectives, and can also move within a small range to enjoy the immersion of VR. In VR animation, the audience's position, i.e., the camera's position, becomes more important than the camera's field of view and angle [3]. Therefore, in studying VR animation, the camera's position is an important factor to look at. The main purpose of this study is to investigate the effect of gender on the comfortable viewing distance of VR animation and to reveal the differences in experiencing VR technology between different genders.

As the application of VR technology in entertainment, education, healthcare, and other fields is becoming increasingly widespread, demands are getting higher on user experiences and comfort. However, current research on VR animation mainly focuses on analysis, including narrative modes [4-6], performance techniques [7-9], sightline design [10-12], features [13-15], production technology [16-18], and other related aspects. There is little research on gender differences in VR viewing experiences, and this study fills the gap in existing literature on gender differences in VR technology. Studying the influence of gender on VR viewing experience from the perspective of comfortable viewing distance is very practical. Viewers of different genders may have different visual needs and perceptions, so determining a comfortable viewing distance can improve user experience and satisfaction, reduce potential discomfort in the VR environment, and provide reference for the development and design of VR animation and even virtual reality applications.

Research on the significance of gender to VR viewing experiences can also provide a foundation for explorations of the influence of VR technology on human perception and behavior. This helps us better understand the impact of virtual reality technology on human cognition and behavior, while also aiding in the development of better virtual reality applications.

2. Literature Review

VR technology is a rapidly growing field that has seen increasing use in a variety of applications. This technology allows users to experience immersive environments through the use of specialized hardware and software. At its core, VR technology consists of a headset or other display device that presents users with a three-dimensional, computer-generated environment. Users typically interact with this environment using handheld controllers or other input devices, and may also experience haptic feedback to enhance the sense of immersion.

VR technology has numerous applications across a wide range of industries. In the entertainment industry, it is commonly used to create immersive gaming experiences or to provide virtual tours of museums and other cultural institutions. In education and training, VR can be used to simulate real-world scenarios and provide hands-on learning experiences. In medicine and therapy, it can help manage pain, anxiety, or other conditions by giving patients immersive experiences. While VR technology has many potential applications, it also has some limitations. For example, it can be expensive to develop and implement, and not all users are comfortable when fully immersed in a virtual environment. Additionally, there are concerns about the potential for addiction or other negative psychological effects. Despite these limitations, VR technology is a rapidly growing field that is poised to revolutionize many industries. As the technology continues to improve, it is likely that we will see even more innovative applications of it in the future.

In his book The Hidden Dimension, Edward T. Hall defines proxemics as a term for interrelated observations and theories of man's use of space. According to Edward's description, distance between people could be divided into four categories: intimate distance, personal distance, social distance, and public distance [19]. Intimate distance, which ranges from 0 to 45 centimeters, is characterized by intense emotional expressions such as tenderness, comfort, love, and even strong anger. Personal distance, which spans from 0.45 to 1.30 meters, is typically observed between close friends or in families, for example, during conversations at the

dinner table. Social distance, which covers a range from 1.30 to 3.75 meters, is the appropriate distance for ordinary conversations among friends, acquaintances, neighbors, and co-workers. Lastly, public distance, which is greater than 3.75 meters, is reserved for more formal situations such as those involving public figures or one-way communication, as well as when someone wishes to observe an event without becoming involved [20].

Based on proxemic patterns, the distance between individuals changes according to the level of intimacy, indicating the existence of personal space. Personal space (PS) is a movable safety zone around the body used for obstacle avoidance during locomotion [21]. PS is asymmetrical in social settings and affects people's distance from others. Studies indicate that the concept of PS is also relevant in VR environments, where it maintains its overall shape and asymmetry [22]. PS is typically of an oval shape with twice as much space in the front as in the back and sides, as shown in Figure 1 [23]. Human movement follows the same rules in VR as in real life [24], and audience members maintain a certain distance from virtual characters due to their personal space. Consequently, a comfortable distance exists between viewers and virtual characters in the virtual space, varying based on individual sensory differences but still related to proxemic distance intervals.

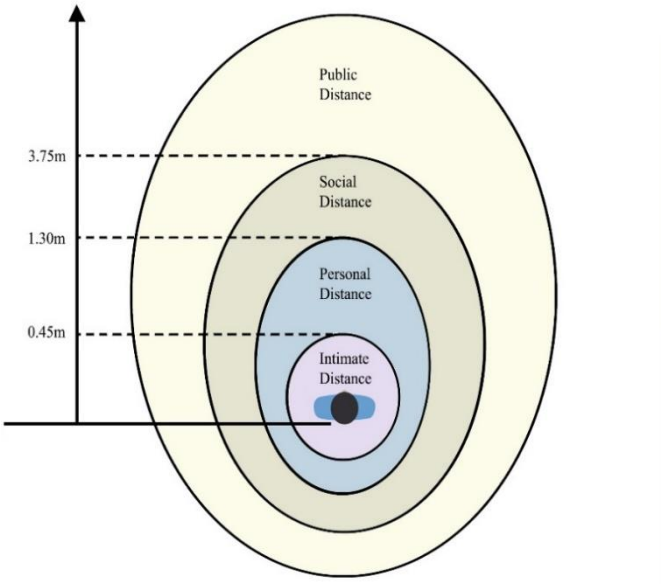

Figure 1. Definition of the Personal Space in Virtual Space

Comfortable viewing distance is an important factor in VR technology. It refers to the optimal distance between the user and the virtual environment, which ensures the best visual experience and reduces the risk of negative physical and psychological effects. The importance of comfortable viewing distance in the virtual world can be attributed to several factors. Firstly, VR technology relies heavily on the sense of immersion, which can be achieved by creating a realistic and comfortable virtual environment. If the viewing distance is too short or too long, it can lead to discomfort and disorientation, which will undermine the sense of immersion and the overall VR experience. Secondly, comfortable viewing distance is closely related to the user's physical health and safety. Studies have shown that prolonged exposure to VR from incorrect viewing distances can cause symptoms such as headaches, eye strain, and even nausea. Therefore, it is essential to establish a comfortable and safe viewing distance in order to minimize the risk of negative physical and psychological effects. Lastly, comfortable viewing distance is critical for the success of VR applications in various fields, such as entertainment, education, and healthcare. If users cannot comfortably engage with VR content, they are less likely to use the technology, which can limit its potential influences and benefits.

In summary, comfortable viewing distance is a crucial factor in the virtual world, which can affect the user's sense of immersion, physical health and safety, and the success of VR applications. Therefore, it is necessary to explore and understand the influence of comfortable viewing distance on user experiences, and to establish guidelines and standards for comfortable viewing distance in VR animation. Studies show that gender is an influencing factor for PS preference, and males have stronger negative reactions to frontal invasions of PS than females [25]. It follows that there should be a significant difference in viewing distance between genders when watching VR animations.

3. Research Design and Methods

3.1 Research Design

To verify the effect of gender on viewing distance, we designed an experiment in which participants were required to wear the VR headset to watch the animation and adjust their position in the virtual space using VIVE controller to find the best viewing point, as shown in Figure 2(a). The distance between participants and animated characters was recorded and analyzed. The animation used in the experiment was Help Us!, which is shown in Figure 2(b). It is an original English fairy tale designed for early childhood English education. This animation was created as a supplement to a textbook and its style is bright and warm to appeal to its target audience [26].

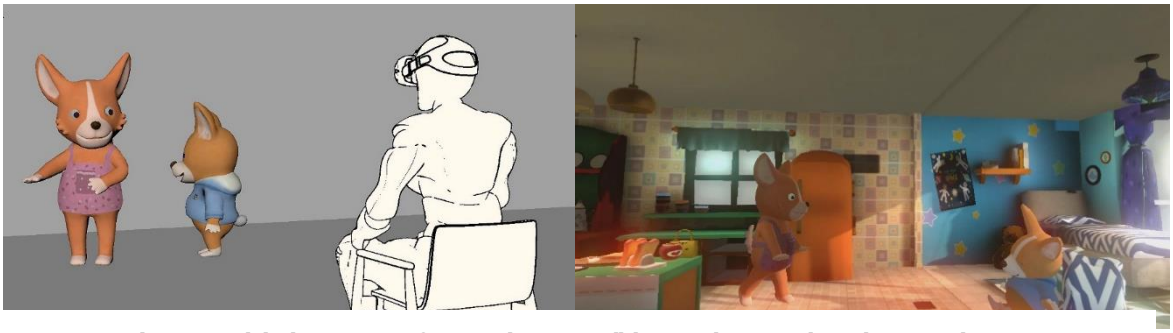

Figure 2: (a)The State of Experiment. (b) VR Short Animation <Help Us!>

3.2 Participant Recruitment and Experimental Equipment

For our experiment, we recruited a total of 100 participants, including 41 males and 59 females. The vast majority of the participants came from Dongseo University. The ages of the participants ranged from 19 to 44 years old, averaging out at 24.

The VR equipment used in the experiment was the HTC VIVE Pro. To ensure smooth operation of the VR equipment, the computer was configured with an Intel(R) Core(TM) i7-7700 CPU @3.60GHz processor, 16.0GB of memory, a NVIDIA GeForce GTX 1050 Ti graphics card, and a motherboard with 8298 (KBC version 06.21).

3.3 Experimental Procedure

To give participants enough time to find their optimal viewing positions, the animation used in the experiment was looped. The experiment was conducted in an indoor setting, and to avoid any interference caused by virtual walls, one wall of the room was removed to expand the virtual space for the experiment. The participants were briefed on the procedure before the experiment started, then they put on the headset and sat on a chair in the middle of the room to watch the animation. Using the VIVE controller, they were asked to move around in the virtual space to find the best viewing positions. The script measured the distance between

the camera and the animated character. Each participant was given about 2-5 minutes for the experiment, as shown in Figure 3 [27].

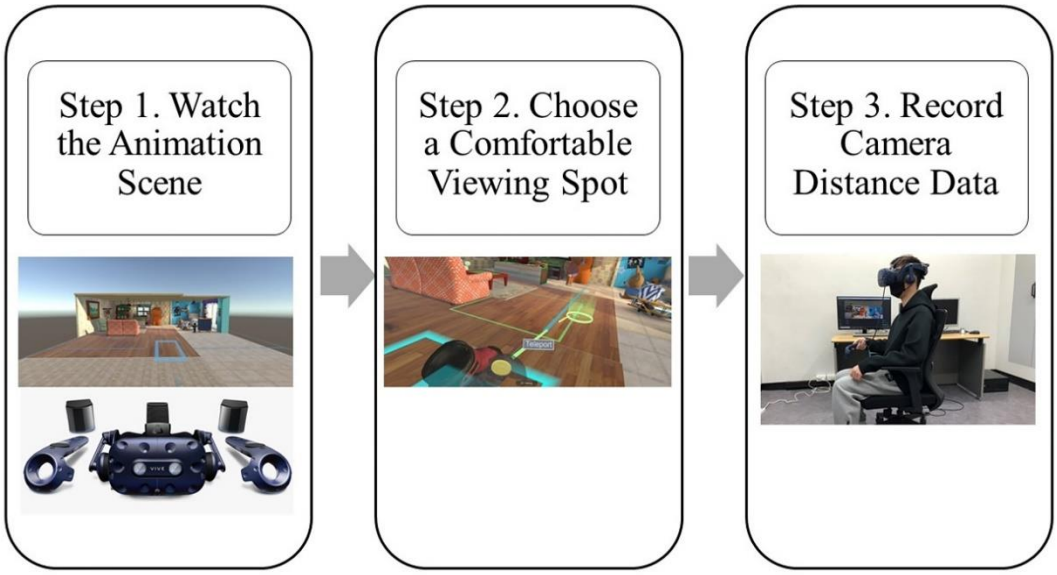

Figure 3. The Process of Experiment

3.4 Results

The viewing distances chosen by the 100 participants in the experiment ranged from 1.50 to 10.41 meters, with a mean of 4.07 meters. These results were then compared with the four distance ranges of proxemics, and it was found that all the data from the experiment fell within the social and public distance categories: 55% within the public distance category, while 45% within the social distance category as shown in Table 1. The data was tested using Mann-Whitney U and yielded data U=1129, p=0.573 as shown in Table 2.

Table 1. Results of Experiment

Gender	Distance Range	No	Distance Avg (m)
Male	Social Distance	21	2.98
	Public Distance	20	5.18
Female	Social Distance	24	2.69
	Public Distance	35	5.05

Table 2. Results of Mann-Whitney Test

	Distance
Mann-Whitney U	1129.000
Wilcoxon W	1990.000
Z	-.564
Asymp. Sig. (2-tailed)	.573

In this experiment，no significant differences were found in comfortable view distance between male and female participants in our sample. Female participants showed greater interpersonal distance when interacting with agents who made eye contact with them (i.e. mutual gaze behavior) than with agents who did not make eye contact. In contrast, male participants did not show this difference [28]. Participants do not make eye contact with virtual characters in VR animations, which may also explain the lack of significant gender differences in comfortable viewing distances.

4. Discussion and Interpretation

Although our experimental results indicate no significant gender differences in comfortable viewing distance, we can interpret this result from different perspectives. On the one hand, the rapid development of VR technology has made the viewing experience of VR animations more comfortable and realistic, and minimized the effects of gender differences. On the other hand, gender differences in comfortable viewing distance may not be universally present but have to be triggered by other factors like vision and spatial perception. Further research is needed to explore these factors.

The limitations of this study mainly lie in the sample selection and experimental design. Our participants mainly come from a specific population and may not represent the characteristics of the entire population. Additionally, our experimental setting may be subject to interference from other factors. In future research, experiments can be designed more rigorously by, say, using a larger sample and taking interference factors into consideration, to study the role of gender differences in VR animation viewing experiences. Furthermore, the influence of other factors on the comfortable viewing distance can be explored to optimize the design and use of VR animations.

For example, we can explore whether there are significant differences between different age groups, or whether there are differences in perception and interaction with VR animation for people with different levels of VR technology experience. We can also analyze the effects of different display resolutions or fields of view settings on comfortable viewing distance. By analyzing these additional results, we can know better how to optimize VR animation to provide the best experience for users with different needs and preferences.

5. Conclusion

This study explored the role of gender differences in VR animation viewing experiences, particularly the influence on comfortable viewing distance. Through experiments and data analysis, we have drawn the following conclusion: there is no significant difference in comfortable viewing distance between males and females. This result suggests that gender differences may not be a main factor affecting the VR animation viewing experience, and more attention should be paid to other factors such as picture clarity and animation content.

VR technology has a wide range of applications in fields such as entertainment, education, and healthcare. The conclusion of this study can provide some guidance for optimizing the design and use of VR animations. For example, designers can focus more on aspects such as image clarity, animation content, sound effects and motion simulation, to enhance the user's sensory experience. Besides, efforts can be made to explore areas such as psychotherapy and vocational training to expand the application scope of VR technology.

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